Master Plan for Neyveli Area

Draft Final Report

Submitted to

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March 1995

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List of abbreviations

AEQM	-	Area-wide Environmental Quality Management
Mt	-	Million tonnes
MW	-	Mega Watts
DO	-	Disolved Oxygen
EIA	-	Environmental Impact Assessment
ETP	-	Effluent Treatment Plant
EMP	-	Environmental Management Plan
PAL	-	Point Area Line
USEPA	-	United States Environmental Protection Agency
MSL	-	Mean Sea Level
B&C	-	Briquetting and Carbonisation
TS	-	Thermal Station
CARD	-	Centre for Applied Research and Development
Ha	-	hectare
mcm	-	million cubic metre
PLF	-	Plant Load Factor
SPM	-	Suspended Particulate Matter
SO_2	-	Sulphur dioxide
NO_x	-	Nitrogen oxide
CPCB	-	Central Pollution Control Board
CO	-	Carbon monixide
RPM	-	Respirable Particulate Matter
μg	-	micrograms
DGMS	-	Directorate General of Mine Safety
COD	-	Chemical Oxygen Demand
BOD	-	Biological Oxygen Demand
TSS	-	Total Suspended Solids
USBM	-	United States Bureau of Mines
PWD	-	Public Works Department
SC	-	Scheduled Caste
ST	-	Scheduled Tribe
DRDP	-	District Rural Development Programme
GWC	-	Ground Water Control
DBH	-	Diameter at Breast Height
COV	-	Coefficient Of Variation
kWh	-	kilowatt hour
BWE	-	Bucket Wheel Excavator
ESP	-	Electrostatic Precipitator
MDC	-	Mechanical Dust Collectors

HAD - Hydro Ash Disposal
CDM - Climatological Dispersion Models
TPS - Thermal Power Station
TNPCB - Tamil Nadu Pollution Control Board
OB - Overburden
EC - Electric Conductivity

Chapter 1. Scope and methodology

1.1 Background

The total prognosticated geological reserves of lignite in the country, as brought out by detailed exploration activities carried by different state and central agencies upto 1992, are estimated at about 15,835 Mt. Out of these reserves 13,555 Mt, occur in the state of Tamil Nadu and the break-up is as follows: Neyveli - 3,300 Mt, Jayamkondam 1,150 Mt, Mannargudi 8,050 Mt and east of Veeranam - 1,255 Mt. The Bahour field in Pondicherry has an estimated reserves of 580 Mt. In Tamil Nadu, at present there are only Neyveli lignite field is being mined by the Neyveli Lignite Corporation. The lignite is mostly consumed in two pit-head thermal power stations with an installed capacity of 2,070 MW. In addition there is a fertiliser plant and a briquette & carbonisation plant.

Keeping in view the increasing needs for power in the southern states and the potential reserves of lignite in the area, NLC has formulated proposals for greater exploitation of the lignite deposits. These development activities would involve a lignite production of about 40 Mt/a and a power generation capacity of about 7,000 MW in the area by 2020. Such massive additions to mining and power generation in a limited area would raise many issues including environmental issues which have to be addressed. Keeping this in view, NLC Ltd has entrusted M/s LAUBAG Consulting the task of preparing a master plan for the lignite deposits in Neyveli area, including Jayamkondam and Bahour. The TERI as an associate of LAUBAG Consulting in this project is entrusted with the task of preparing an integrated EIA and EMP for the master plan projects of NLC.

1.2 Objectives

The major objectives of the study are as follows:

1.2.1 Preparation of an Environmental Impact Assessment (EIA) report, identifying possible adverse effects of the Master Plan project activities due to mining, power generation and other industrial activities on the environment namely: air quality, surface and ground water quality, water balance, noise levels, ground vibration levels, topography, climate, drainage, flora, fauna, land use, socio-economic conditions, health and welfare facilities. The impact study covers a radial distance of 30 km surrounding all the proposed master plan projects of the 3 lignite fields. The time horizon selected for the study is upto 2020.

1.2.2 Preparation of an Environmental Management Plan (EMP), for the protection of the above environmental parameters. This includes, among other items plans for land reclamation, rehabilitation, ground water control, solid waste management and noise pollution control.

1.3 Methodology

The following methodology has been designed to cover all the items identified in the contract:

environmental survey
environmental monitoring
environmental impact assessment
environmental management plan

The details of the methodology are as follows:

.3.1 Environmental survey

Select the boundaries of the area of study
Even through the area of the study extends from Pondicherry in the north to Coleroon river in the south and Vridhachalam town in the west to the Bay of Bengal in the east, the area of interest is restricted to areas covered by the master plan projects. The study area is divided into sub-areas namely, Neyveli, Jayamkondam and Bahour covering the lignite fields.

Identify the activities in the sub-areas with respect to individual major activity i e. power plant, mining, transport and domestic

Estimate the generation and discharge of the pollutants from the various existing activities and the conditions of discharge

Survey of eco-systems

Survey of socio-economic status

1.3.2 Environmental monitoring

To assess the background environmental quality, field monitoring has been carried out for the following:

- air quality for 3 seasons
- water quality for 4 seasons
- soil for 4 seasons
- noise 3 times in the year
- ground level vibration - once
- meteorological data during sampling months

1.3.3 Environmental quality assessment

a. Project levels of population and economic activities for a future time horizon of interest (2020).

b. Assess the impacts due to future activities on air quality, water quality, noise levels, land occupation, displacement of population and eco-systems.

1.3.4 Environmental management plan

Based on the assessment of impacts on the environment due to future master plan activities, a detailed environmental management plan will be devised which will suggest the pollution abatement and control measures to be adopted to minimise the environmental impacts.

This report is organised in the following manner.

Section 2	gives a description of the area.
Section 3	describes the existing status of environment in the area.
Section 4	estimates the generation and discharge of pollutants from the existing activities in the area. For air pollutants, emissions are translated to ambient concentration levels using the USEPA - PAL model.

Section 5	describes the future economic activities in the area.
Section 6	covers the impacts on the environment due to future activities.
Section 7	presents the environmental management plan.

Chapter 2. Description of the study area

2.1 Location and extent

The study area extends from Pondicherry in the North to Jayamkondam in the south and falls under the east coastal plains of Tamil Nadu and Pondicherry. It is situated between 10.55' north latitude and 79.50' east longitude and covers an area of about 6000 sq km in the districts of Pondicherry, South Arcot, Tiruchirapalli, and Thanjavur. The study area is well connected by rail and road network with Madras and other important towns of South India. Historically and commercially the study area has been very important from the beginning of the 6th century and has been ruled by the Pallavas, Cholas, Pandyas, Nayanars and Marathas. Many temples of architectural grandeur were constructed between 8th and 13th centuries by the different kings ruling the area.

2.2 Premining scenario

Agriculture has been the most dominant occupation in the coastal plains since ancient times. Irrigation has been practiced here since ancient times through anicuts and tanks. The Grand Anicut in its original form belonged to the Sangam era of the early Chola kings at the junction of the Cauvery and the Coleroon rivers. It was built to prevent the flood water running off waste through the Ullur Channel. Canals and tanks form the chief sources of irrigation in the area. These are linked with river systems, but in places which are not served by rivers, there are numerous small rain-fed tanks built one below the other

A number of anicuts have been built across the Ponnaiyar, Vellar and Manimuktar for irrigation purposes Artesian wells are also found in South Arcot district especially in Vridhachalam taluk, Cuddalore taluk and Pondicherry. These are associated with the Tertiary acquifiers of Cuddalore sandstones. Water was available at a depth of about 5 m and the water tables goes deeper to 7 m or more during summer.

Crop pattern

Rice, pulses, sugarcane, cotton, groundnuts, cashew nuts and gingli are the most important crops within this study area. The principle rice growing areas are in the deltaic belt of Chidambaram and northern portion of South Arcot district. But as one goes inland where rainfall decrease and there is less waterlogging, cash crops like plantains, sugar cane, cashew are grown along with paddy. Ragi is concentrated in the poor soil tracts of Udayarpalayam and Vridhachalam taluks. The oil seeds grown are groundnuts and gingli, while coconuts are grown all along the coast. Rice-jowar, bajra-oilseeds zone is associated with the taluks of Udayarpalayam in Trichy district and Kalaikurichi, Vridhachalam and Tirukovilur in South Arcot. In this area of 750-1000 mm rainfall, rice occupies 25-50% of the total cultivated area.

Forests

The forest in the area can be grouped into:

i) Most tropical forest in the coastal areas, which include littoral forests, tidal swamp mangrove scrubs and forests,

ii) Dry tropical forests which include southern dry mixed deciduous forest, dry deciduous scrub, southern thorn forest, southern thorn scrub, souther euphorbia scrub and tropical dry evergreen scrub.

Between 1924 and 1956, most of the forests in the area were under the Panchayat management. During this period the condition of the forests had deteriorated considerably, partly due to destructive methods of exploitation and partly due to mismanagement. During this period many of the forests which supported dense forest growth formerly turned into open scrub jungle.

In 1957, the Cuddalore forest division was reconstituted for rehabilitation of the ex-Panchayat reserve forests. In 1959, the division was bifurcated into two divisions, namely north and south. In the next decade, large scale afforestation work was carried out in both the divisions. In 1968, the two sub-divisions were merged again to form Cuddalore division. In 1974, all cashew bearing areas and most of the other better types of areas fit for planting Eucalyptus were leased out to Tamil Nadu Forest Plantation Corporation (new organisation for managing plantation).

2.3 Topography, drainage and landscape

2.3.1 Neyveli sub-area

This area is mostly a flat-terrain, sloping gently from north to south and west to east. The main hills are the Kalrayans, on the western border and the red hills near Cuddalore. The Kalrayans divides South Arcot district from Salem district, raising to a moderate height of 600 m to 900 m abruptly from the surrounding plains. (However, no portion of this range of hills lies in the study area). The historic Athur pass at its southern end leads into Salem district. The general slope is towards the east along which flow the main streams which drain it, namely, Manimuktar, Gomuki and Mayura rivers.

The red hills which run parallel to the sea with an elevation of not more than 30 m above M.S.L. extends from Cuddalore where it is known as Mount Cappen Plateau, to the north near Marakanam in Kumalambattu Reserved Forest and to the south near Srimushnam.

The Ponniar is the main river of this tract, originating in the Chinna Kesava hill in Karnataka state. It flows through the districts of Dharmapuri, Salem, North Arcot, South Arcot and Pondicherry and joins the Bay of Bengal near Cuddalore. There are 2 dams on the river. One near Krishnagiri and the other at Sathanur (North Arcot) and an anaicut near Tirukovilur (South Arcot).

The Gadilam rises in the eastern part of Tirukoilur taluk and enters the Cuddalore taluk where the Malattar joins it, then it flows past Panrutti and through Tiruvendipuram and Cuddalore and falls into the Bay of Bengal. Ordinarily, the Gadilam is dependent on local rain and during the floods, it receives large supply of water from Ponniar through the Malattar. It carries fertile silt and it has across it four anaicuts which help irrigation.

The Uppanar or the Parvanar rising in Vridhachalam taluk is by and large a drainage channel and falls into the sea near the mouth of the Gadilam near Cuddalore old town.

The Northern part of Kalrayans are drained by Mani and Mukta streams which joins together to forum the Manimukta river, Gomuki and Mayura draining the southern part of the Kalrayans joins Manimukta river which in turn joins Vellar near Sethiatope.

Vellar is formed by the confluence of Vashistanadhi and Swetanadhi which rise in Salem district. The Vellar joins the sea at Port Nova and there are a number of anaicuts on the river.

In the Neyveli area there are number of water tanks, the major ones being the Peria eri, Walaja tank, Perumal eri and Veeranam tank. A list of tanks with their location is given in Annexure 2.1. Walaja tank is located 4.5 to 5 km to the east of Mine II and 8.5 to 10 km to the South-

East of Mine I and other industrial units namely Fertilizer plant, B&C plant and Thermal station. It receives water from the Upper Parvanar and the combined effluents of Fertilizer and B&C plants. It also receives water from the Mine I as a result of storm water control pumpage discharge and its own catchment area. Volumewise, mine water entering into the walaja tank is 25 to 30 times more than the volume of combined effluent entering into it. The water from this tank enters Perumal eri, and the water course between the Walaja and the Perumal eri is known as "Middle parvanar".

Perumal eri is situated 7 km to the East of Walaja tank and receives water from the Walaja tank via the middle Parvanar. Apart from the walaja tank it receives huge amount of water from its large catchment area. The eri leads the water to the sea through the lower Parvanar or Uppanar.

Veeranam tank is located 3 to 3.5 km South of Vellar river. It is the largest tank having maximum command area and capacity. At present it doesn't receive any water arising from the activities in the NLC complex. It receives water from its own catchment area and from the lower anaicut of Coleroon river. The overflow from this tank enters into the Vellar river.

Table 2.1 gives features of the major tanks in the Neyveli region.

Table 2.1. Features of major tanks in Neyveli area

Tank/ features	Command area (sq km)	Capacity (mcm)
Veeranam tank	181.5	28.03
Walaja tank	46.1	2 55
Perumal eri	26.31	16 26

2.3.2 Jayamkondam sub-area

The Jayamkondam area lies to the south-west of Neyveli and occupies the central portion of Udayarpalayam taluk. The Coleroon river controls the drainage system of the area. This area is also mostly a flat terrain sloping gently towards east and south-east Surface elevation increases from 20 to 80 m above mean sea level as we move towards the west

This area is also nourished by tanks which are limited in number. Generally, the ponds are monsoon dependent but the tank in Udayarpalayam had water in all the seasons. The list of tanks with their location in given in Annexure 2.2. The largest tank is Ponneri near Puduchavadi east of Jayamkondam which is dependent on monsoon and remain dry during the rest of the year. In the proposed mine area, the Malangankudiruppu Odai acts as the natural drainage course and joins the Ponneri tank.

2.3.3 Bahour sub-area

The Pondicherry area in general is a flat plain with an average elevation of about 15 m above the mean sea level. However, a major physiographic units are observed in the area viz. the Coastal plain and alluvial plain.

Coastal plain
The coastal plain is straight and stretches along the Bay of Bengal for about 22 km with a breadth ranging from 4 to 600 m. The sea coast has a narrow flat beach with sea water almost touching the main land at some places. The major portion of the coastal plain comprises of gently sloping lands with a chain of sand dunes almost extending all along the coastal area.

Alluvial plain
This unit occupies a major portion of the Pondicherry area Two major rivers flow across the alluvial plain and drain into the Bay of Bengal. The alluvial plain are generally flat monotonous plain with slope ranging from 1 to 3%. Micro depression topography are very common in the alluvial plains. The lands are parcellaired into small plots for cultivation purpose. The alluvial plains are intensively cultivated with crops all round the year. Besides the rivers and major canals there are depression storage tanks spread all along the terrain which serve as water reservoirs. A list of water tanks in the area with their location is given in Annexure 2.3. The major tanks in the area are the Bahour tank and Osteri tank. The Bahour tank has a capacity of 5.6 mcm and covers an ayacut area of 3 9 sq km while the Osteri tank has a capacity of 15.3 mcm and covers an ayacut area of 15 7 sq km.

Drainage
There are two important rivers viz. River Gingee and River Ponniar which with their tributaries drain the Pondicherry area into the Bay of Bengal. The River Gingee flows across diagonally from north-west to south-east. This river is also known as the Varahanadi or Sankaraparani.

The river Gingee has its source at the hills of Malayanur in the South Arcot district of Tamil Nadu. Though the river has a total length of 7 km, it has a run of only about 34 km in this area. The river splits off int two branches namely Ariankuppam river in the north and Chunnamba in the south. The river Gingee is not a perennial river and it flows onl during the rainy season.

2.4 Population

The population of the study area in 1991 is estimated at 2.5 million. Th share of urban population in 1991 was 38.6 %. There are 14 towns in th study area. Out of these towns, 3 have population exceeding 1,00,000 The details are given in Table 2.2.

Table 2.2. Settlements according to population size in the study area

Population	Number of Villages
below 25,000	7
25,000-50,000	1
50,000-75,000	3
75,000-1,00,000	0
above 1,00,000	3
Total Villages	14

The population details of the towns are given in Table 2 3.

Table 2.3. Population in 14 towns of the study area

No.	Name of the Town	Population
1	Panrutti	51394
2	Nellikuppam	42783
3	Neyveli	118080
4	Thorapadi	6538
5	Cuddalore	144561
6	Kurinjipadi	23117
7	Cuddalore port	4962
8	Vridhachalam	52819
9	Gangaikondan	8809
10	Chidambaram	58740
11	Bhivanagiri	17605
12	Parangipettai	23550
13	Annamalai Nagar	9209
14	Pondicherry	401437

2.5 Architecture

2.5.1 Places with historical and national importance

1. **Temples**
The following temples were constructed during the 10th and 11th century by the Chola kings.

Neyveli sub-area

a) Nataràja temple in Chidambaram. It is a beautiful temple depicting the best of Dravidian architecture. Two of the gopuram are covered with 108 classical postures of Lord Nataraja. Another unique feature is the 1000 pillar hall.

b) Vridhagiriswarar temple, an ancient Shiva temple in Vridhachalam.

c) Sri Bhuvarahaswamy temple (Lord Vishnu) in Srimushnam.

Bahour sub-area

a) Umapitariyan temple (Lord Shiva) in Bahour. There are six stone scripts in this temple which tells about the importance of Bahour during the Chola regime.
b) Varadaraja Perumal temple located in Thirubhuvanai.
c) Thiruvandar temple located in Thirvanadarkoil.
d) Madagadi pattu Shiva temple.
e) Thirumudaran Palli (Lord Shiva) located in Pandacholanalor.
f) Villianor Shiva temple.

Jayamkondam sub-area

a) Sri Brahadeeswarar temple at Gangakonda Cholampuram. the temple is also an example of beautiful Chola architecture. The gopurams of this temple dominates the landscape for miles around. There are many beautiful sculptures on the walls of the temple. A tank was also constructed near the temple called the Ponneri tank.

2 **Water tanks**

The whole study area has an interactive tank system, built centuries ago for bringing about highly profitable irrigation. This system of connecting a series of tanks by channels, enabled the flow of water from the highest point (elevated area) to lowest point (downstream area) via series of tanks. This process of regulating the flow of surface water through channels and tanks is highly efficient since it results in proper storage of water and thereby prevents surface run-off and floods. Due to the increase in the retention time of the water, it also results in an increase in infilteration quantum into the ground, and prevention of water logging At present the maintenance operation of these tanks is undertaken by the public works department and other local authorities, and many a times by the native people themselves.

The important tank names along with their capacity and ayacut areas has been discussed above.

3 **Mangrove Forests**

Reserved forest at Pichavaram is located 16 km east of Chidambaram It covers a vast area criss-crossed by backwaters, thus forming several islands with mangrove forests.

2.6 Landuse

The land use pattern details in the study area are given in Table 2.4.

Table 2.4. Land use pattern (Figures in Ha)

Item	Bahour	South Arcot district	Jayamkondam (around core mining area)
Total geographical area	29,377	3,81,034	36140.78
- Forest land	Nil	7,093	1252.12
- Land put to non-agri use	8,562	51,913	-
- Barren and uncultivable land	80	13,326	-
- Permanent pasture and other grazing land	Nil	855	1027.22
- Land under misc tree crops	1,821	20,507	-
- Cultivable wasteland	831	6,971	-
- Fallow land	3,048	17,050	-
- Net area sown	15,035	2,43,205	12437.23

It can be observed from the table that agriculture occupies the major share of land in all the three areas. Taluk-wise land use details are given in Annexure 2.4. At present mining of lignite is being carried out only in Neyveli sub-area. A total area of 2528 Ha has been occupied by mining operations till 1994 (Mine I: 1410.8, Mine II: 1117.4).

2.7 Water resources

2.7.1 Ground Water

The main water source for the mining region is groundwater. Surface water in several tanks and river water do not correspond with the groundwater below the lignite seam due to the very thick and unpermeable sandstone formations (Cuddalore Sandstone). Except in southern part of the region the Coleroon River seems to have some influence on the groundwater level. During a very short observation period of 4 years the observation wells in Jayamkondam area do not show any reaction on the groundwater lowering in the mining area. This can be caused by a small river bank infiltration from Coleroon river to the semi-confined aquifer in that region To confirm this hypothesis some additional investigations (pumping tests, observations) are required.

The general flow direction of the ground water in master plan area is from the west towards the east to the Bay of Bengal, which means that the so-called Neyveli Basin is replenished from the west. The main groundwater recharge takes place in a region located in the western part of the investigation area. With geological terms this zone is limited by the outcrops of Cretaceous Hardrocks. Here the footwall sands crop out and form a unconfined aquifer, which is directly recharged by infiltrating rain water. Due to a less evapotranspiration rate (less vegetation) the recharge rate is relatively high and has been found to be about 15% of the rainfall. The recharge area is relatively large and an annual recharge of about 167 Mill m^3 (mcm) has been estimated for the whole area. In the past this amount of groundwater used to flow into the Bay of Bengal. In some parts of the basin the groundwater pressure head was higher then ground surface (artesian groundwater).

The main groundwater users excluding mines pumpages are: agriculture (irrigation pumpage and artesian outflow), Neyveli township (water supply), industrial units around Neyveli and industrial units in SIPCOT

2.7.2 Surface water

The rivers and many ponds in the study area are rainfed and remain dry during the other seasons. The surface water is mainly used for irrigation purposes and is not used for drinking purposes except Coleroon river The Coleroon river water is drawn from infiltration well of about 5 m depth and is supplied to the population in Jayamkondam, Udayarpalayam, and Silal for drinking purposes.

2.8 Economic activities in the area

A preliminary analysis was carried out which involved identifying the activity categories and major activities which generate residuals of concern. These residuals of concern include all those which affect the ambient environmental quality of the area The major individual activities are identified by sub-areas and specific locations. Five major activity categories are delineated in the study. These are mining, power generation, industries, transportation, residential The levels of production and specific locations with respect to individual major activities are given in the following paragraphs.

2.8.1 Mining

The lignite deposits in the study area extend from Bahour in the North to Jayamkondam in the south. However, at present lignite mining is only carried out in Neyveli area.

Neyveli sub-area

In the Neyveli sub-area, the lignite field is extending over an area of 480 sq km with a total inferred reserves of about 3300 Mt Out of this total area, nearly 200 sq km has been prospected in detail by NLC and other agencies, proving a total mineable reserves of more than 2000 Mt. The lignite mining activity started in the early 1960s and initially Mine I was designed for an annual lignite output of 3.5 Mt. It was expanded to 4.5 Mt in 1972 and again to 6.5 Mt in 1983. In the 1980s, Mine II was planned for 4.2 Mt in Phase I and for 10.5 Mt in Phase 2. The lignite production in this field increased from 0.36 Mt in 1962-63 to 14.14 Mt in 1993-94. The details of production in 1993-94 are as follows, 6.14 Mt in Mine I, 8 Mt in Mine II.

Jayamkondam lignite field
This field is contagious to Neyveli field with a barren zone in between and lies about 22 km in the strike extension. In the late 1980s regional exploration was carried out in this lignite field by GSI and MECL. Based on these, the total reserves of lignite in the entire lignite field of about 120 sq km is estimated at 1150 Mt. The mineable reserves are estimated at about 286 Mt in an area of 28.63 sq km. However, no mining activity has started in the area till now.

Bahour lignite field
The Bahour lignite field covers an area of 35 sq km and the lignite reserves are estimated at about 480 Mt. Mining has not started in this lignite field.

2.8.2 Power generation

The power generation activities are concentrated in Neyveli sub-area only where lignite deposits are being mined. There is no other power plant in the area. In Neyveli, there are two power plants namely TS-1 and TS-2 with an installed capacity of 600 MW and 1470 MW respectively.

TS-1
TS-1 comprises of 6 units of 50 MW each and 3 units of 100 MW each and these were commissioned between 1962 and 1970. The performance of this plant in 1993-94 is given in Table 2.5

Table 2.5. Unit-wise performance details of TS-1 (1993-94)

Unit No.	Capacity (MW)	Year of installation	1993-94	
			PLF (%)	Generation (mill.units)
1	45*	1962	L.E.P	-
2	45*	1963	83.16	327.80
3	50	1963	84.02	367.99
4	50	1963	54.35	238.05
5	50	1964	76.05	333.12
6	50	1965	80.44	352.34
7	100	1967	B/D	27.27
8	100	1969	82.81	725.397
9	95**	1970	L.E.P	-
	585	Total		2371.97

* 50 MW unit derated to 45 MW

** 100 MW unit derated to 95 MW

The lignite consumption was 3.37 Mt with a specific lignite consumption 1.422 kg/kWh. The average PLF for the plant was 72 %.

TS-2

It has 7 units of 210 MW each and these were commissioned between 1986 and 1993. The performance details in 1993-94 are given in Table 2.6. The lignite consumption was 8 Mt. with a specific lignite consumption of 1 145 kg/kWh. The average PLF of the plant was 63 %

Table 2.6. Unit-wise performance details of TS-2 (1993-94)

Unit No.		Capacity (MW)	Year of installation	1993-94	
				PLF (%)	Generation (mill.units)
1	Stage 1	210	1988	63.65	1170.9
2		210	1987	57.93	1065.7
3		210	1986	60.99	1121.9
4	Stage 2	210	1991	50.09	921.4
5		210	1991	51.23	942.9
6		210	1992	66.56	1224.5
7		210	1993	40.18	577.5
	Total	1470			7024.5

2.8.3 Industrial sector

Major industrial activities are more pronounced in Bahour and Neyveli sub-areas. In Jayamkondam, there is no industrial activity except for cement plant which is located at about 30 km from the proposed mining area. There are 8 industrial units in Bahour area and 5 units in Neyveli area, including the 3 operated by NLC. In addition there are many small and medium scale industries in Sedarpet and SIPCOT industrial areas. In spite of our best efforts, many of the units did not furnish data regarding their production, fuel consumption, waste load discharge, etc. Apart from NLC units we could get data only for a few units. A summary of the industrial units, type of product, their capacity and production are given in Table 2.7.

Table 2.7. Performance of industrial units in 1993-94

No	Unit	Product	Unit	Annual production/ capacity	Remarks
	Neyveli sub-area				
1	Fertiliser plant	Urea	Tonnes	1,11,000	
2	Briquette & carbonisation plant	Leco (lignite briquette)	"	2,27,000	Lignite
		Carbolic acid	"	678	consumption 0 9
		Ortho eresol	"	116	Mt
		mp ereosol	"	434	
		Xylenol	"	195	
		mv phenol	"	446	
		Dephonilised oil	Kilolitre	1,249	Lignite 0 44 Mt
		Tar	Tonnes	14,356	Cap 2500 TPD
3	Steam generation plant	Steam	t/hr	120	Only 96 days
4	MRK Sugar mill	Sugar	Tonnes	28,171	worked in 93/94
5	Chemicals & plastics India Ltd	Industrial alcohol	Kilolitre	6,720	
	Bahour sub-area				
1	Pondicherry organic chemicals	3 chloro 4 fluro arciline	Tonnes	240	
2	JBF industries	Trichloro ethylene	"	6,000	
		Tetrachloro ethylene	"	8,000	
		Perchloro ethylene	"	2,000	
		Heachloro ethylene	"	100	
3	Nycer India Ltd	Ceramic tiles		NA	
4	Silical Metallurgic Ltd	Ferrosilicon	"	3,000	
5	Pondicherry Paper Ltd	Printing and writing paper	"	9,000	
6	Mittal Ispat Private Ltd	Steel ingots	"	20,000	
7	East coast steel Ltd	Billets	"	1,98,000	
8	Prot-chem industries Ltd	L-Crystine	"	84	
		L-Jynosine	"	24	
		Amino acid parts	"	500	

2.8.4 Transport sector

Neyveli sub-area

95% of the lignite production is consumed in pit-head power stations (in Neyveli) and is transported from the mine to the power station through conveyor systems. Transportation of lignite briquettes and raw lignite to industrial units is by rail and road. In addition, movement of freight within the area and passing through the area is also heavy. Passenger transportation in the area is largely through buses (public transport system).

The road network in Neyveli area comprises of two categories viz, State Roads and NLC roads. The state roads in the study area are essentially Major District Roads and Other District Roads The roads in NLC township area are under the direct control of NLC. The details of Roads and traffic flows are as given in Table 2.8

Table 2.8. Details of Transport Activities in Neyveli sub-area

No.	Name of the highway	Length (km)	Width (lanes)	Traffic flow (vehicle/day)		
				Buses/trucks	Cars/jeeps	2-wheeler
1	Vridhachalam-Cuddalore	58.2	2	3155	1312	2721
2	Madras-Tanjore	28.2	2	3001	1119	1054
3	Vridhachalam-Portonovo	50	2	1064	841	1017
4	Neyveli-Valayamadevi	8.6	1	240	204	514
5	Vridhachalam-R.Pattinam	6.8	1	1882	930	1070
6	Vridhachalam-Ullundurpet	20	2	1602	727	826
7	Perumal Tank bund road	14.6	1	824	57	240
8	Kullanchavadi-Kattagudalore	14	1	513	348	515
9	Cuddalore-Chidambaram	18.6	2	1030	348	185
10	Vridhachalam-Tholundur	10	2	1786	755	803
11	Bhuvanagiri-Kurinjipadi	17.6	1	738	246	704
12	Kurinjipadi-Palur	20	1	807	772	648
13	Vridhachalam-Kattagudalore	19.6	1	778	790	790
14	Vridhachalam-Palakollai	19.5	1	256	256	127

Besides these, many other approach roads to villages are also in use whose length is generally less than 5 km.

Jayamkondam sub-area
It is well connected by road. The Madras-Tanjore Highway passes by Gangaikondapuram which is about 9 km. from Jayamkondacholapuram. Jayamkondacholapuram is also well connected to Tiruchirapalli by a major district road Since this area is not industrially developed, majority of the traffic on the highways is passenger traffic. The traffic on these roads is very less as can be seen from the Table 2.9.

Table 2.9 Details of Transport Activities in Jayamkondam sub-area

No.	Name of the Highway	Length (km)	Width (lanes)	Traffic flow (vehicle/day)		
				Bus/trucks	Cars/jeeps	2-wheelers
1	Trichy-Chidambaram	34	1	876	398	645
2	Madras-Tanjore	20	2	966	280	227
3	Jayamkondam-Vndhachalam	23 6	1	602	308	683
4	Jayamkondam-Madanathur	18	1	264	141	113
5	Jayamkondam-Sindurai	25	1	274	170	87
6	Jayamkondam-Snmushnam	5	1	463	126	193
7	Udayarpalayam-Silal	10	1	45	15	100
8	Silal-Anicut	9.6	1	77	20	69
9	Vanyankavul-Mathur	15.2	1	47	16	38
10	Udayarpalayam-Sindurai	17 8	1	81	13	228
11	Kallattur-Papakudi	13 8	1	135	86	101
12	T.Palur-Vilangudi	20 2	1	34	10	33

Bahour sub-area

It is situated in the southern part of Pondicherry, and is well connected by a network of highways. Important ones among them are Pondy-Cuddalore highway, Villupuram-Pondy (NH 45 A) national highway These roads are said to carry maximum traffic in this area. Detailed traffic flow data for the various roads in Bahour area is not available The length and width details of these roads are given in Table 2 10.

Table 2.10. Details of Transport Network in Bahour sub-area

No	Name of the highway	Length (km)	Width (lanes)
1	Villupuram-Pondicherry (NH)	25	2
South Division			
2	Abhishekapakam Road (Mudugarai-Cuddalore Rd Junction)	18	2
3	Pondicherry-Cuddalore	17 4	2
4	Villianur-Bahour	11 4	2
5	Madugari Rd.(starting from Villupuram Rd)	18 6	2
6	Archiwalk-Emblam	9 3	2
7	Cuddalore Rd starting-Kirumampakkam	4 6	2
North Division			
8	Marakkonam Road	4 5	2
9	P S. Palayam Road	9 6	1
10	Vadhanon Road (Sellipet causeway to State Boarder)	6	1
11	Kothapurinathan Road (Kalitheerthal kuppam to State Boarder)	5	1
12	Suthu Kemy Road (Suthipet Road culvert to Suthiketry bunglow)	6 4	1
13	Sanniyasikuppam road-moolakulam-konerikuppam river	6 3	1
14	Valudavam road	8 8	1
15	Sedarpet road	10 3	1
16	Mathur Road	7 1	1

Source: Highways and Rural Roads Department. .

Besides these, many other approach roads to villages are also in use whose length is generally less than 5 km

Chapter 3. Status of the environment - existing scenario

3.1 Climate

The climate in Neyveli and Jayamkondam (both inland areas) is characterised by slight extremes of heat and cold. Bahour, a coastal area, is characterised by higher humidity, and less extremes of temperature. May and June are the hottest months with maximum temperatures ranging from 35-39°C and minimum temperatures from 24-28°C. January is the coldest month with maximum temperatures ranging from 29-31°C and minimum temperatures from 19-22°C. The predominent wind direction is from the south-west during the months of June to September. From October to March the predominent wind direction is from the north-east.

Rainfall in the study area generally varies from 550 mm to 1500 mm with a dry period of 5 to 6 months. The annual average rainfall in Pondicherry area over a period of 50 years is 1233 mm. The annual average rainfall for South Arcot district over a period of 30 years is 1108 mm. The average rainfall for Jayamkondam area over a period of 20 years is 1090 mm. Table 3.1 gives rainfall statistics over a period of 30 years for South Arcot District. The rainy season is from July to December. However, about 60% of the rainfall occurs in three months - October, November and December, which correspond to the north-east monsoon season.

Table 3.1. Rainfall statistics for South Arcot district

Season	Avg seasonal rainfall (mm)	Lowest rainfall in one season (mm)	Highest rainfall in one season (mm)
S-W monsoon (June-Sept)	378.8	192.7	592.7
N-E monsoon (Oct-Dec)	569.1	184.7	1137.5
Winter (Jan-Feb)	49.0	4.5	138.0
Summer (Mar-May)	111.4	20.0	692.2
Total	1108.3	401.9	2560.4

3.2 Present environmental quality

During the past two decades, the Neyveli sub-area has sustained a high rate of growth in lignite and power production. In Bahour sub-area, a number of industrial units have been established in the 1980's, eg SIPCOT (Cuddalore), Pillayarkuppam (Bahour), etc. Many of these are polluting industries eg. paper, steel, chemicals, etc. However, Jayamkondam sub-area has not attracted any industrial activity till now. This growth in Neyveli and Bahour sub-areas has been accompanied by a change in the quality of the environment (land, water and air), particularly in the mining and industrial areas. Generation of residuals from the various activities and damage to land due to mining operations have increased in the last two decades.

3.2.1 Air quality

Neyveli sub-area

The major sources of air pollutants are (a) TS-1, TS-2 and B&C plants, (b) to a limited extent, dust due to mining and erosion from overburden dumps and lignite dump; and (c) to a very limited extent, from transportation and domestic activities

The air quality in this area can be characterised as good CARD (NLC) is monitoring SPM, SO_2, NO_x for 6 stations in the vicinity of the plants 3 of the stations are in the township while the other 3 are located at nearby villages. Results over the past years indicate that air quality is much below ambient standards with annual averages for the 6 stations ranging from 61 to 87 $\mu g/m^3$ for SPM, 7 to 21 $\mu g/m^3$ for SO_2, and 16 to 22 $\mu g/m^3$ for NO_x.

Jayamkondam sub-area
This zone has no major polluting industries/ sources and the air appears to be fairly clean. There was no continuous monitoring of air quality in the past.

Bahour sub-area
Although the proposed mining area is situated in agricultural surroundings, the Bahour zone is fairly industrialised. The major sources of air pollutants are industries located in Pillayarkuppam and to a lesser extent from transport and domestic activities. In this area also, there was no continuous monitoring of air quality in the past.

3.2.1.1 Air quality monitoring in the study region

Air quality in the area has been monitored to assess the impact of pollutants from various industries, power stations and mines and other activities. Air quality sampling and analysis has been carried out for 3 seasons as per CPCB standards. These data serve as background information to assess the impacts of future master plan projects.

Monitoring Network
Ideally a monitoring network should be designed based on the following factors:

- sources of pollution
- wind direction and speed
- potential impact targets (population and sensitive zones)

It was extremely difficult to apply the above criteria due to inadequate data relating to the location of future sources and the limitations posed by a two-point meteorological data (available from CARD). The proposed areas for future mining were only tentatively known. Source siting of power plants had not been made. Additionally, data on wind speed and direction monitored by CARD for Neyveli region were instantaneous measurements at 0830 and 1430 hours. For Jayamkondam the nearest continuous meteorological data available was for Trichy/ Kallakurichi - both of them are over 30 km away For Bahour, Cuddalore IMD meteorological data was used.

Confronted by the above difficulties, the monitoring network for the study region was based on geographical coverage and representativeness. The network, comprising of 16 stations in the Neyveli region, 5 in Jayamkondam and 4 in Bahour is shown in Figure 3.1. Table 3.2 gives a brief description of the 25 stations.

Table 3.2. Air quality stations and description of their local surroundings

No.	Station Name	Description of the local area
	Neyveli	
A 1	Block 17	Residential
A 2	Kurinjipadi	Residential/ agricultural (NLC planning to put up TPS nearby)
A 3	Kullanchavadi	Agricultural/ residential
A 4	Sethiathope	Residential/ agricultural
A 5	Srimushnam	Historic temple/ residential
A 6	T V Puttur	Agricultural/ residential
A 7	Sathamangalam	Agricultural/ residential
A 8	Nadukuppam	Agricultural
A 9	Kadampuliyur	Agricultural
A 10	C Mutlur	Mangrove forests
A 11	Bhuvanagiri	Residential/ agricultural
A 12	Cholatharam	Commercial
A 13	Valayamadevi	Agricultural
A 14	Andimadam	Proposed 3rd mine area
A 15	Vridhachalam	Residential/ agricultural
A 16	Ulundurpet	Residential
	Jayamkondam	
A 17	Jayamkondam	Proposed mine cut area/ residential/ commercial
A 18	Gangaikondacholapuram	Archaeologically sensitive
A 19	T Paluvur	Residential/ agriculture
A 20	Udaiyarpalayam	Residential/ commercial
A 21	Irugalankurichi	Residential/ agriculture
	Bahour	
A 22	Thiruppampakkam	Falls in proposed mine cut area/ agriculture
A 23	Mudhaliarpet	Residential/ commercial
A 24	Cuddalore	Commercial/ residential
A 25	Valavanoor	Proposed site for thermal power station/ residential

Figure 3.1. Locations of air quality monitoring stations

Monitoring parameters and schedule

The air quality monitoring has been conducted to assess the concentration levels of Suspended Particulate Matter (SPM), Sulphur dioxide (SO_2), Nitrogen oxides (NO_x) and Carbon Monoxide (CO) at various stations in Neyveli, Jayamkondam and Bahour regions. Eight hourly samples were collected from each station making upto 3 samples each for SPM, SO_2, NO_x and CO per day. Sampling was done for two days in a week and four weeks in a month. The monitoring was conducted for 8 days in each area per season for 3 seasons. The monitoring period was spread over the months of May-June '94, August-September '94 and December '94 - February '95 for Summer (1st), Monsoon (2nd) and Winter (3rd) seasons respectively.

The Gazette of India notification dated 20th May, 1994 has made the measurement of RPM-10 statutory in industrial, residential and sensitive areas. The selection of sites for the measurement of RPM-10 was done according to the criteria of

- zone of maximum pollutant concentration,
- regions of population exposure,
- projected growth and representativeness of the area

The monitoring of RPM-10 is being conducted in 8 sampling stations, 6 of which are in Neyveli area, and one each in Jayamkondam and Bahour areas. In each station, twenty four hourly sampling is being carried out for two days in a week and four weeks in a month. RPM-10 sampling was done for 8 days in each area for 3rd season The monitoring period extended between December '94 and February '95

Sampling procedure

Ten High Volume Samplers of Envirotech APM 415 model were used for the monitoring exercise. Glass fibre filter paper (Whatman GF/A) was used for collecting SPM. The concentrations of SO_2 and NO_x were determined by using the Improved West and Gaeke method (IS 5182, PART II) and Hochheiser modified method (IS 5182, PART IV) respectively for all the stations. Three respirable dust samplers of Envirotech 451 model are being used to measure the RPM-10 CO is being measured by Instantaneous Meters.

Standards

Ambient air quality standards prescribed by CPCB are given in Table 3.3.

Table 3.3. Ambient air quality standards of CPCB

Area	Parameters in $\mu g/m^3$			
	SPM	SO_2	NO_x	CO
Industrial	500	120	120	5000
Residential	200	80	80	2000
Sensitive	100	30	30	1000

These standards have been recently modified (Gazette of India, Extraordinary, dated May 20, 1994) and are reproduced in Table 3.4.

Table 3.4. Modified ambient air quality standards of Government of India

Pollutant	Time weighted avg	Concentration in ambient air			Method of measurement
		Industrial area	Residential, rural & other areas	Sensitive area	
Sulphur Dioxide (SO_2)	Annual avg* 24 hours**	80 $\mu g/m^3$ 120 $\mu g/m^3$	60 $\mu g/m^3$ 80 $\mu g/m^3$	15 $\mu g/m^3$ 30 $\mu g/m^3$	1. Improved West & Gaeke method 2. Ultraviolet fluorescence
Oxides of Nitrogen (NO_x)	Annual avg* 24 hours**	80 $\mu g/m^3$ 120 $\mu g/m^3$	60 $\mu g/m^3$ 80 $\mu g/m^3$	15 $\mu g/m^3$ 30 $\mu g/m^3$	1. Jacob & Hochheiser modified (Na-Arsenite) method 2. Gas Phase Chemiluminescence
Suspended Particulate Matter (SPM)	Annual avg* 24 hours**	360 $\mu g/m^3$ 500 $\mu g/m^3$	140 $\mu g/m^3$ 200 $\mu g/m^3$	70 $\mu g/m^3$ 100 $\mu g/m^3$	High Volume sampling, (avg flow rate not < 1.1 m^3/min.)
Respirable Particulate Matter < 10 um (RPM)	Annual avg* 24 hours**	120 $\mu g/m^3$ 150 $\mu g/m^3$	60 $\mu g/m^3$ 100 $\mu g/m^3$	50 $\mu g/m^3$ 75 $\mu g/m^3$	Respirable particulate matter sampler
Lead (Pb)	Annual avg* 24 hours**	1.0 $\mu g/m^3$ 1.5 $\mu g/m^3$	0.75 $\mu g/m^3$ 1.00 $\mu g/m^3$	0.50 $\mu g/m^3$ 0.75 $\mu g/m^3$	AAS Method after sampling using LPM 2000 or equivalent filter paper
Carbon Monoxide (CO)	8 hours** 1 hour	5.0 mg/m^3 10.0 mg/m^3	2.0 mg/m^3 4.0 mg/m^3	1.0 mg/m^3 2.0 mg/m^3	Non dispersive infrared spectroscopy

* Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly/ 8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on 2 consecutive days.

Note:

1. National Ambient Air Quality Standards: The levels of air quality necessary with an adequate margin of safety, to protect the public health, vegetation and property.
2. Whenever and wherever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/ continuous monitoring and further investigations.
3. The State Government/ State Board shall notify the sensitive and other areas in the respective states within a period of six months from the date of Notification of national Ambient Air Quality Standards.

3.2.1.2 Ambient air quality monitoring results

The ambient air quality monitoring results for SPM, SO_2, NO_x and CO are given in Table 3.5. CO monitoring for the missed first season is being carried out during the months of March-May '95 Additionally RPM-10 monitoring is also being carried out during March-May '95 in 8 stations.

Table 3.5. Air quality monitoring results (1994) - Seasons I, II and III

#	Station name	Season I				Season II				Season III			
		SPM	SOx	NOx	CO	SPM	SOx	NOx	CO	SPM	SOx	NOx	CO
	Neyveli												
1	Block-17	90	17	26	-	104	16	17	561	60	6	40	572
2	Kurinjipadi	102	14	35	-	66	6	11	307	69	4	26	340
3	kullanchavadi	99	7	36	-	84	6	17	546	128	4	13	556
4	Sethiatope	92	5	39	-	77	6	8	774	107	4	22	756
5	Srimushnam	62	5	22	-	62	4	10	422	102	11	25	419
6	T V Puthur	75	7	28	-	79	9	10	438	78	5	15	423
7	Sathamangalam	65	17	15	-	72	11	12	263	83	8	13	279
8	Nadukuppam	81	26	34	-	53	7	13	507	69	6	21	512
9	Kadampuliyur	96	20	55	-	70	5	13	327	71	3	23	352
10	C Mutlur	49	10	26	-	47	5	7	405	45	5	16	411
11	Bhuvanagiri	61	6	33	-	60	7	6	246	82	6	21	238
12	Cholzatharam	85	7	24	-	67	5	11	471	74	7	24	489
13	Valayamadevi	119	10	26	-	71	15	9	546	63	7	23	533
14	Andimadam	80	7	25	-	59	4	11	574	69	10	17	574
15	Virudhachalam	59	10	15	-	54	9	14	364	69	7	30	374
16	Mangalampet	60	9	22	-	54	4	9	523	63	7	18	531
	Bahour												
17	Cuddalore	85	11	11	-	64	3	11	392	68	3	10	3873
18	T P.Pakkam	78	9	10	-	71	4	14	545	115	3	23	44
19	M.R.Pet	131	15	10	-	115	6	19	506	89	3	19	507
20	Valavanur	70	6	13	-	7	6	12	518	116	3	23	521
	Jayamkondam												
21	Jayamkondam	77	5	5	-	70	5	10	474	101	5	12	472
22	G K S Puram	155	7	9	-	117	6	17	580	95	6	19	582
23	T Paluvur	76	6	6	-	56	5	9	322	68	4	10	317
24	Udayarpalayam	81	7	4	-	77	6	9	438	94	7	9	439
25	Irumulaikurichi	105	10	4	-	104	7	17	412	113	8	14	417

Note:

Results are based on 3 eight-hour monitoring shifts per day for 2 days in a week and for 4 weeks in a season.

* Monitoring station is on the road-side and therefore indicates a higher value than the surrounding areas due to fugitive dust.

As can be seen from the table the values of SPM, SO_2, NO_x and CO are very low. CO values are almost negligible with values reaching a maximum of 1 ppm in some of the stations Figures 3.2, 3 3 & 3 4 show the isopleths for SPM, SO_2 and NO_x

Figure 3.2. Isopleths for SPM levels in the study area

Figure 3.3. Isopleths for SO_2 levels in the study area

Figure 3.4. Isopleths for NO_x levels in the study area

Table 3.6. Air quality monitoring results (1994) - annual averages (95 % confidence range)

No.	Station	SPM	SO2	NOx
1	Block-17	85 ± 11	13 ± 5	28 ± 11
2	Kurinjipadi	79 ± 13	8 ± 5	24 ± 8
3	kullanchavadi	103 ± 15	6 ± 2	22 ± 7
4	Sethiatope	92 ± 13	5 ± 2	23 ± 10
5	Srimushnam	75 ± 11	7 ± 2	19 ± 5
6	T.V.Puthur	77 ± 9	7 ± 2	18 ± 6
7	Sathamangalam	73 ± 13	12 ± 7	13 ± 2
8	Nadukuppam	68 ± 10	13 ± 6	23 ± 6
9	Kadampuliyur	79 ± 15	9 ± 4	30 ± 10
10	C.Mutlur	47 ± 6	7 ± 3	16 ± 5
11	Bhuvanagiri	68 ± 11	6 ± 2	20 ± 7
12	Cholzatharam	75 ± 11	6 ± 2	20 ± 5
13	Valayamadevi	84 ± 18	11 ± 3	19 ± 5
14	Andimadam	66 ± 10	7 ± 3	18 ± 3
15	Virudhachalam	61 ± 10	9 ± 3	20 ± 5
16	Mangalampet	59 ± 11	7 ± 2	16 ± 4
17	Jayamkondam	83 ± 10	5 ± 1	9 ± 2
18	G K.S.Puram	122 ± 16	6 ± 2	15 ± 3
19	T.Paluvur	67 ± 6	5 ± 1	8 ± 2
20	Udayarpalayam	84 ± 6	7 ± 2	7 ± 2
21	Irumulaikurichi	107 ± 9	8 ± 2	12 ± 3
22	Cuddalore	72 ± 8	6 ± 3	11 ± 1
23	T.P.Pakkam	88 ± 13	5 ± 1	16 ± 4
24	M.R.Pet	112 ± 13	8 ± 4	16 ± 3
25	Valavanur	86 ± 12	5 ± 1	16 ± 3

3.2.1.3 Respirable Dust Monitoring Results

Ambient RPM-10 monitoring results

Results of RPM measured at 8 locations in Neyveli, Jayamkondam and Bahour areas are given in Table 3.7. Day wise detailed RPM results are presented in Annexure 3.1. The maximum, minimum and mean concentrations are found to be lower in all the stations when compared with the prescribed CPCB standards for residential area (100 $\mu g/m^3$). The possible reasons for the relatively higher values in Mandarakuppam, Jayamkondam and Sethiatope are as follows:

The heavy vehicular traffic and stockyard of Mine I seems to be responsible for higher respirable dust concentration in Mandarakuppam town. As Jayamkondam station was located in the downwind side of road, probably the dust emission from the vehicular traffic are responsible for higher values of respirable dust in this station. In Sethiatope the higher values could be a result of the sugar mill operating in the area.

Table 3.7. Respirable dust concentration ($\mu g/m^3$) at different locations in Neyveli, Jayamkondam and Bahour areas

Location	# of days	Maximum	Minimum	Mean	SD	CV
Block 17	8	59.8	22.7	38.65	12.97	33.55
Sethiatope	8	93.2	29.1	47.08	20.12	42.74
Sathamangalam	8	59.4	19.6	42.87	15.33	35.76
Block 29	8	37.4	15.8	26.75	7.59	28.38
Kammapuram	8	55.1	21.6	33.68	10.52	31.24
Mandarakuppam	8	83.5	33.0	52.1	18.64	35.78
Jayamkondam	8	93.4	34.8	58.91	21.92	37.22
Tiruppanampakkam	8	50.1	31.0	41.7	5.99	14.37

SD - Standard deviation
CV - Coefficient of variation

Respirable dust levels in mining areas

CARD (NLC) has been measuring the respirable dust concentration at different locations in Mine I & II. The details are given in Table 3.8.

Table 3.8 Respirable dust concentration at different locations in Mine I & Mine II

Location	Respirable dust concentration, mg/m^3	
	Mine I	Mine II
Lignite bench Bucket Wheel Excavator (BWE) working area	1.39	0.92
Surface bench BWE cutting face	1.36	0.80
Surface bench spreading area	0.42	0.60
Middle bench BWE working area	0.17	1.00
Lignite bunker spreader working area	Not measured	0.60

Source: CARD, NLC.

From the results, it can be observed that the respirable dust concentration at cutting (lignite/overburden) and discharge (overburden) benches and lignite bunker areas was found to be lower than the prescribed standard of DGMS (Directorate General of Mine Safety) for respirable dust (3 mg/m^3).

3.2.2 Water quality and quantity

In this study, the water quality in the rivers, ponds and ground water has been studied to assess the impact of effluents from various industries, power stations and mines, and waste water from townships Peria eri, Parvanar river, Vellar river, Walaja tank, Perumal eri, Veeranam tank (in Neyveli sub-area), Bahour tank, Ponnaiyar river (in Bahour sub-area) and Coleroon river, Udayarpalayam tank, Ponneri (in Jayamkondam sub-area) are the major surface water bodies in the study area Sea water intrusion into ground water resource has also been studied in selected borewells. Sampling and analysis for the four seasons have been carried out as per CPCB standards. These data serve as background information to assess the impacts of future master plan projects.

The stations have been selected based on the following criteria,

i) topography and terrain
ii) location of effluent discharge points
iii) flow patterns
iv) best designated use of water
v) population at risk
vi) future master plan projects

3.2.2.1 Water quality - sampling and analysis

In all 28 sampling points were selected comprising of 12 surface water bodies (rivers, tanks, etc.), 8 borewells and dugwells for ground water, 7 effluent streams, and 1 township sewage. In addition, 8 borewells were selected (in the fourth season only) to examine the salt content of the ground water in order to assess whether there is any inrush of the sea water. The list of these stations is given in Annexure 3.2. Figure 3 5 shows the locations of all these water sampling points. The sub-area wise break up of stations is given in Table 3.9. The Figure 3 6 depicts the path followed by the effluent streams before they join the surface water bodies.

Table 3.9. Sub-area wise and category wise break-up of water sampling stations

Sub-area	Surface water bodies	Ground water wells	Effluent streams	Sewage stream	Total
Neyveli	8	5	7	1	21
Jayamkondam	2	2	0	0	4
Bahour	2	1	0	0	3
Total	12	8	7	1	28

Figure 3.5. Locations of water sampling points

8 - 39

Figure 3.6. Paths of effluent streams in the study area

The season wise details of number of samples taken for analysis, for each sub-area is summarised in Table 3.10.

Table 3.10. Season-wise & sub-area wise break-up of water sampling

Sub-area	Surface water bodies	Borewells for groundwater	Effluent streams	Sewage	Total
Season 1					
Neyveli	6	4	2	0	12
Jayamkondam	1	2	0	0	3
Bahour	0	1	0	0	1
Sub-total	7	7	2	0	16
Season 2					
Neyveli	7	4	6	0	17
Jayamkondam	2	2	0	0	4
Bahour	0	1	0	0	1
Sub-total	9	7	6	0	22
Season 3					
Neyveli	7	4	6	1	18
Jayamkondam	2	2	0	0	4
Bahour	1	1	0	0	2
Sub-total	10	7	6	1	24
Grand Total	26	21	14	1	62

The samples were analysed for all the parameters as per CPCB standards (for surface water classification), IS-10500 (1991) (for ground water), and IS-2490 (Part 1)-1981 (for effluent streams and sewage). In addition 3 samples were collected in the third season from Thermal station 1 ash pond outlet, Combined effluent, and Thermal station 2 effluent, and analysed for radioactivity test (gross alpha, and gross beta), for both, suspended and dissolved state solids.

The extra borewell samples for ground water (for sea water intrusion) were analysed for 4 parameters namely chlorides, bicarbonates, carbonates, and pH.

Water quality standards

Primary water quality criteria is based on the designated best use of water. Depending on its quality, the water can be used for drinking, outdoor bathing, propagation of wild life and fisheries, and for irrigation and industrial application. The classification of inland surface water as per CPCB standards is given in Annexure 3.3.

All effluent discharges from the industrial and domestic activities join the surface water and affect its quality. CPCB has prescribed standards for the effluents/wastewater which must be met before they join the surface water body. The standards are given in Annexure 3.4. Standards have also been prescribed for ground water quality and this is given in Annexure 3.5.

3.2.2.2 Water quality analysis results and interpretations

Surface water quality results

Summarised results of the three seasons are illustrated in Figure 3.7, 3 8 & 3.9, one for each season. The anion to cation ratio falls between 0.78 to 1.05 and hence confirms the nonconservative behavior of the surface waters as well as the stability of the analysis results in Figure 3 10.

Figure 3.7. Surface water quality results - Summer season

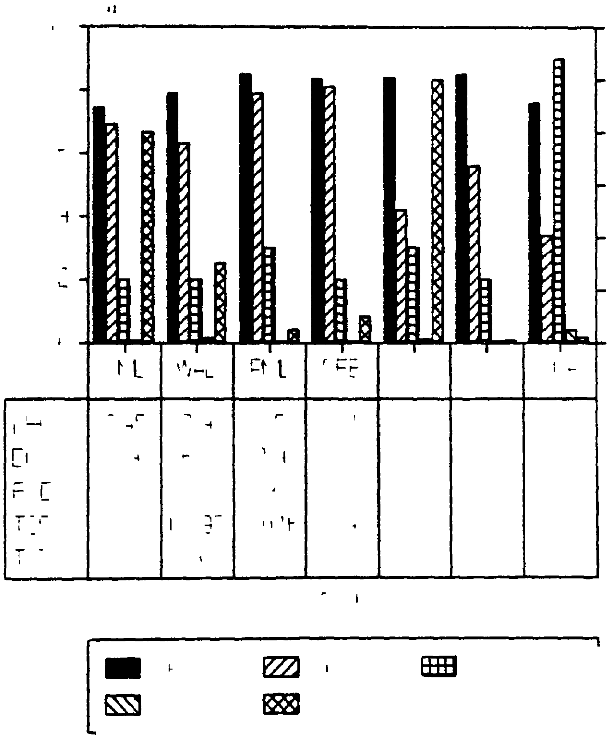


Figure 3.8. Surface water quality results - Pre-monsoon season

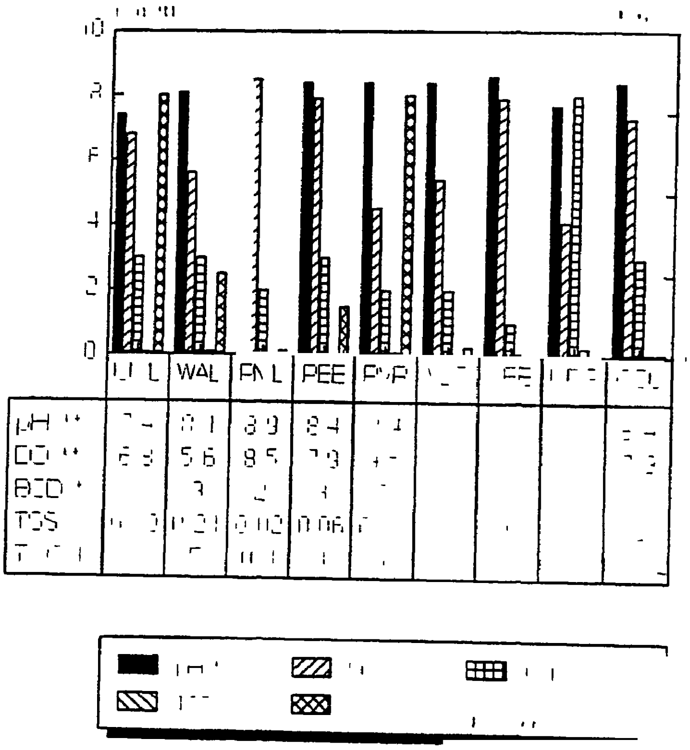


Figure 3.9. Surface water quality results - Post-monsoon season

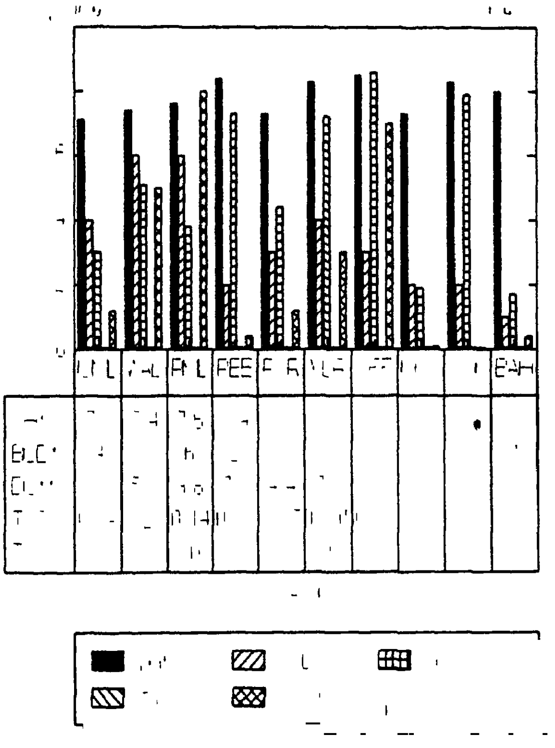
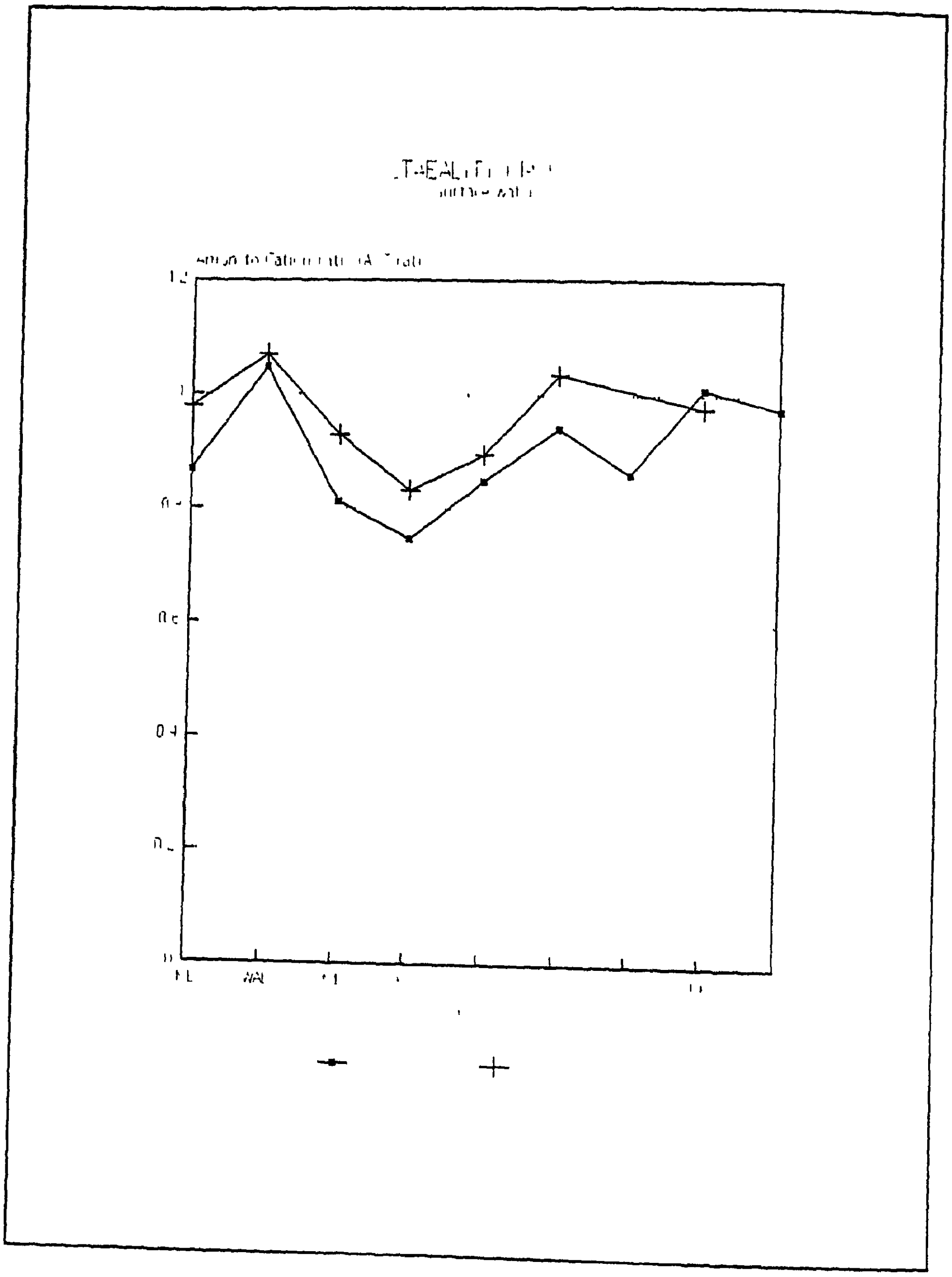


Figure 3.10. Stability analysis for surface waters



Interpretation of surface water quality results
From the analysis results of the surface water samples, it is concluded that Coleroon river lies in Class A, Vellar river and Veeranam tank in Class B, Umangalam, Udayarpalayam and Parvanar river lie in Class D, Peria Eri in Class C and Walaja tank in Class E.

Neyveli
The values for suspended solids are on the higher sides for Walaja tank and Parvanar river. The increase in mainly attributable to the mixing of effluents from fertiliser and B&C plants and mines storm water.

Jayamkondam
The suspended solids concentration was found to vary between 10 to 510 mg/l. Udyarpalayam tank shows high suspended solids (i.e) 510 mg/l. This is due to the fact that the tank is constantly used by the people for bathing, washing and cleaning purposes resulting in the increased load of both organic and inorganic solids.

BOD was found to vary between 3-9 mg/l. For most of the cases it was found to be less than or equal to 3 mg/lt. The maximum values of 9 mg/lt was observed at Udayarpalayam tank in Jayamkondam.

Apart from the above sample analysis, one sample was also collected from **the Ponneri tank** in the post monsoon season, though this sample doesn't fall in the list of selected stations. The sample was collected in order to assess the general characteristics of the water. The results shows that water falls in class 'C' category. This tank remains dry in rest of the seasons. The topography of the region shows that this tank would receive the mine as well as thermal power plant effluents in future after the master plan projects are implemented.

Bahour
The quality of water in Bahour tank was found to be within limits.

Effluents/Wastewaters quality results
All the effluents discharges from the industrial units in Neyveli area namely B&C plant, fertiliser plant, thermal power plants and mines join the surface water and therefore it becomes essential to analyse the effluents. The mine water combines with effluent water in the ratio of 25:1 (minimum) and hence dilutes the untreated effluents before they enter Walaja tank.

Summarised results for the three seasons are illustrated in Figure 3.11, 3.12 & 3.13.

Interpretation of the effluent/wastewater results

Mine I Effluent (Storm water)

In general Mine I storm water effluent is meeting the standards except for TSS. The values are high due to the excessive silt being carried by the flowing water, and due to absence of sedimentation tank and desilting activities in the drains and natural tanks.

Briquetting and Carbonisation Plant

The effluent from the plant is let out into the surface water without any treatment except for phenols. The results show that the TSS values are very high because of the presence of lignite dust. The dust also contributes to the dark color and high turbidity of the effluent water. The analysis of the organic and nutrient parameters showed high BOD of 360 mg/lt and COD 896 mg/lt. Dissolved oxygen was found to be nil for all the seasons, thus confirming the load of organic pollution in the effluent stream.

Oil and grease was found to be very high i.e, 20-200 mg/lt as against 10 mg/lt as per standard.

Phenol indicates a value between less than 1 to 7.6 mg/lt.

Fertilizer

The fertiliser effluent shows a higher value of pH (i.e) 9.6 mg/l for the second season. For the third season the value is within the limits. Among organic and nutrient parameters, ammonical nitrogen showed higher values.

Thermal Station I & II, Ash pond overflow

The main effluent is the supernatant water from the ash pond and the rinse discharge from the water demineralisation plant. The effluents from the boiler blow down, and chemical treatment plant, also join the slurry

The analysis for all the parameters showed that they lie within the prescribed limits.

Figure 3.11. Effluent/ wastewater quality results - Summer season

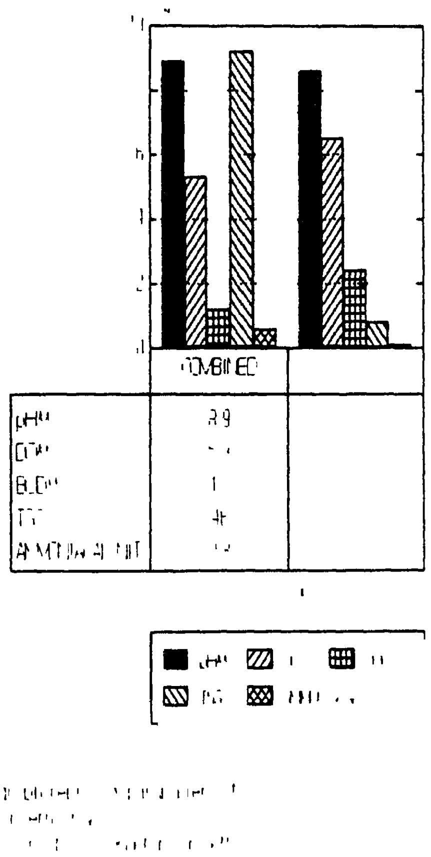


Figure 3.12. Effluent/ wastewater quality results - Pre-monsoon season

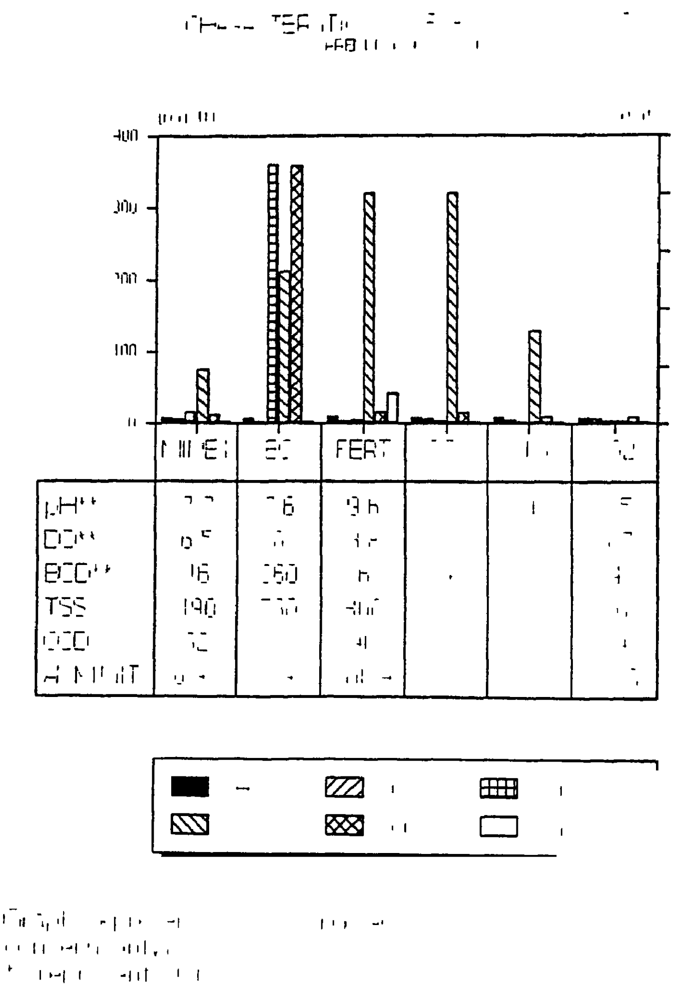
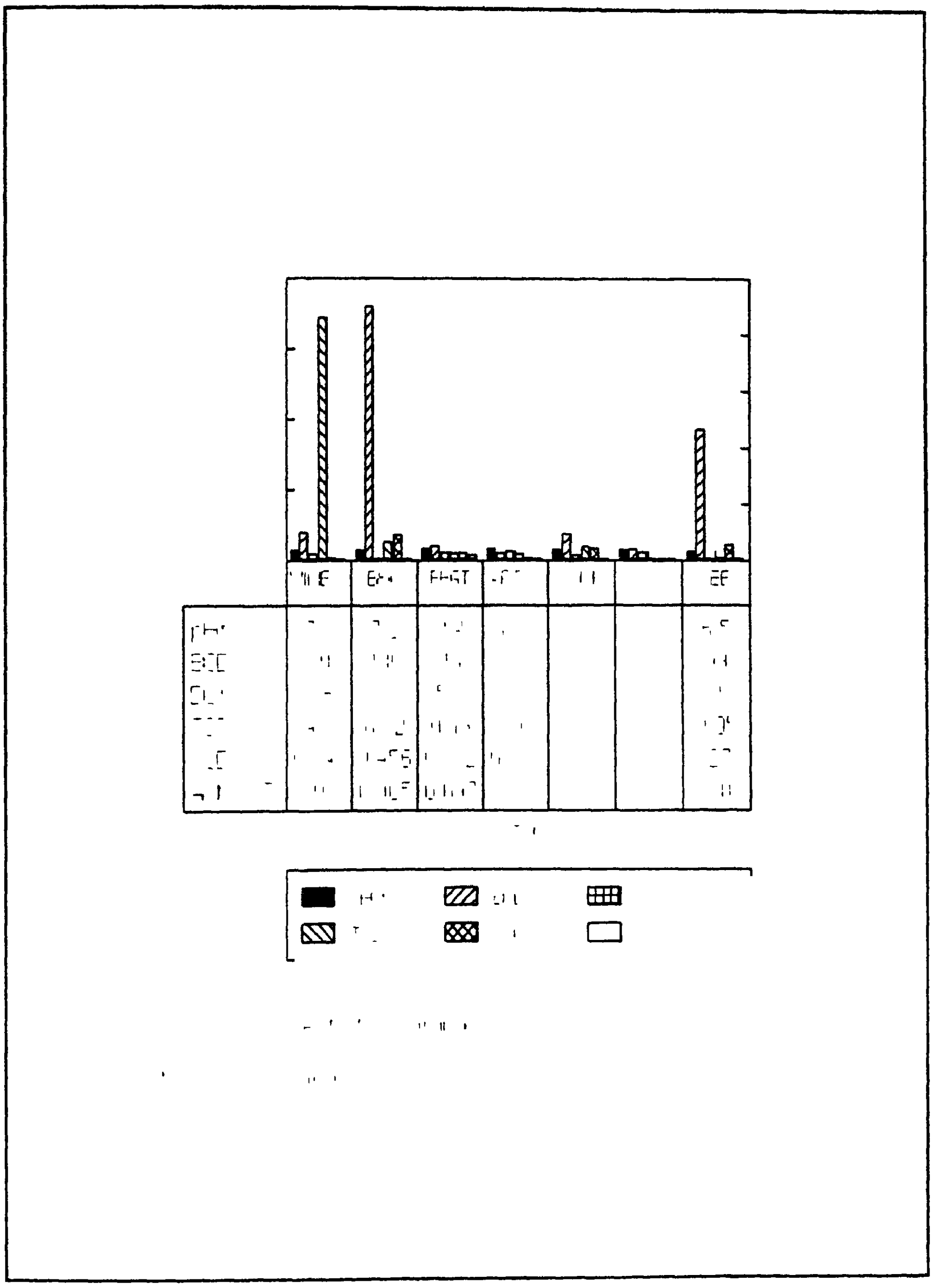


Figure 3.13. Effluent/wastewater quality results - Post-monsoon season



Combined effluent
Combined effluent carries the effluents mainly from B&C plant and Fertilizer plant. This effluent travels via Mandarakuppam and joins Walaja tank where mines I & II water also joins. The analysis of combined effluent shows a high value of TSS. This is mainly attributable to the B&C plant effluent.

The sudden reduction in the value of NH3-N from 106.4 (at source) to 6.03 mg/l could be due to nitrification and oxidation phenomenon. Both are atmospheric phenomenon related to the ecological aspects. Since the passage of effluents is through agricultural fields the occurrence of the above two phenomenon holds good. Nitrification bacteria is found in root nodules.

Waste water from Neyveli township
All parameters are found to be within limits.

Effluent/waste waters: CARD's results
NLC's research lab CARD and TNPCB have been regularly monitoring the effluent samples for the past number of years. The parametric mean values of the samples for some parameters (as per our summerised results) is shown in the Table 3.11. The table given for comparison with our results.

Table 3.11. Parametric mean values for effluent sample results

Parameter	Mine I	B & C	Fertiliser	Combined effluent	TS-1, ash pond overflow	TS-2, effluent
pH	7 12	7 07	9 47	8 32	8 3	7 79
BOD	14 01	289 4	15 25	13 85	4 45	5 71
DO	N A	N A	N A	N A	N A	N A
TSS	122 44	472 2	43 87	69 7	81 75	31 86
COD	114 93	1199	68 52	108 7	53 62	30 65
Amm nitrogen	N A	62 88	141 05	44 38	N A	N A

Source: CARD, NLC.

Ground Water quality results
Summerised results for all the stations are given in Figures 3.14, 3.15 & 3.16, one for each season.

Figure 3.14. Ground water quality results - Summer season

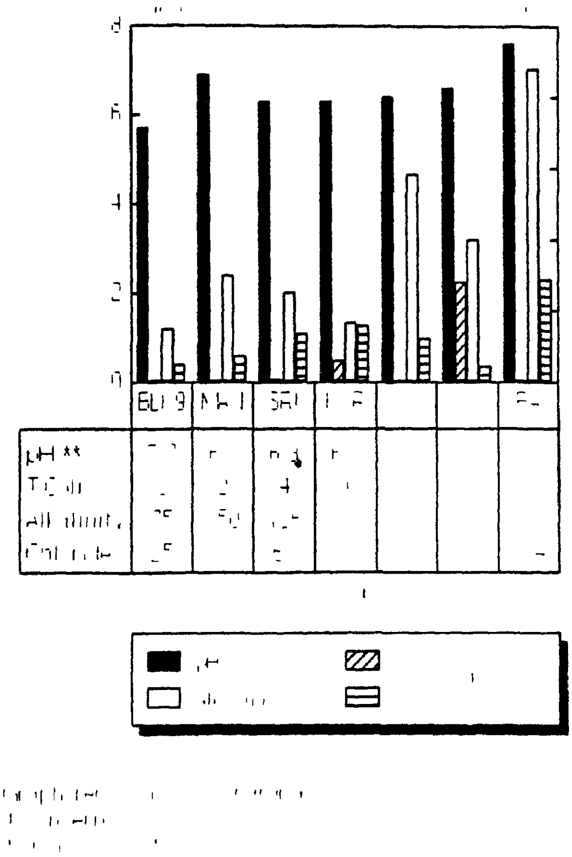


Figure 3.15. Ground water quality results - Pre-monsoon season

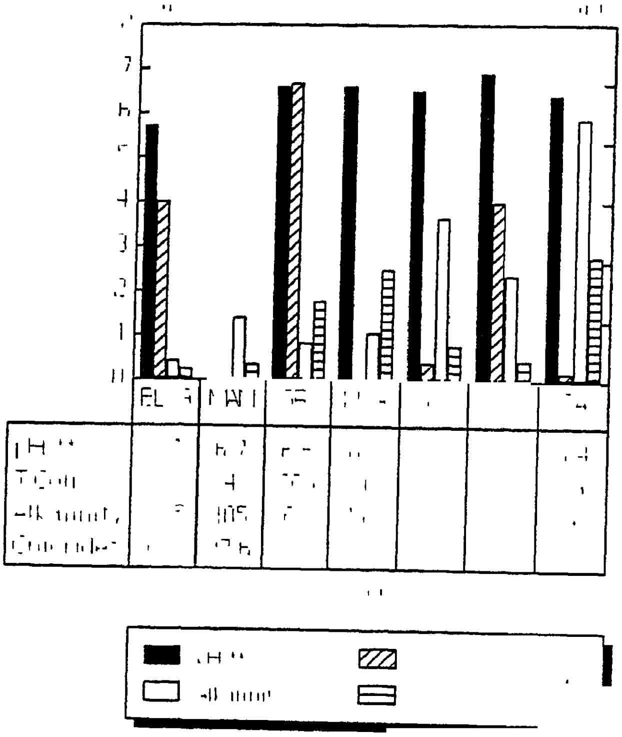
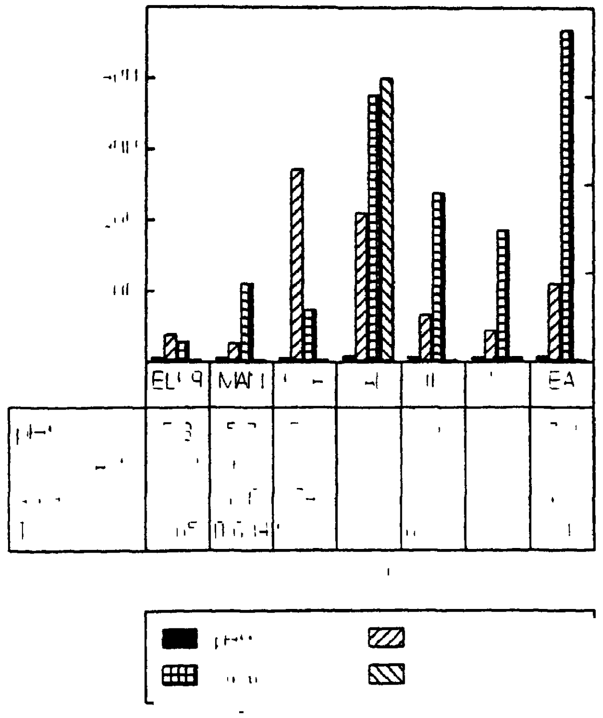


Figure 3.16. Ground water quality results - Post-monsoon season



Interpretation of ground water quality results

The basic characteristics of ground water in all the three regions are similar, such as among the anions bicarbonates are the predominant ions. In all the three regions the water is generally calcium-magnesium-bicarbonate type except in small cases where sulphate and chloride form a dominant group among the ions. Present analysis shows that alkalinity figures fall in the range of 31.5-300 mg/lt and exists in the form of bicarbonate alkalinity.

pH varies between 5.7-6.9. For all the cases the value is on the acidic side of the pH scale. This is due to the presence of oxides of iron and alumina found in the ground water. The soil of the region which is 'Lateritic' confirms the view.

Chloride concentration are found to be within the limits. The alkalinity value exceeds the standard for Bahour sub-area. For Neyveli and Jayamkondam the values are within the prescribed limits

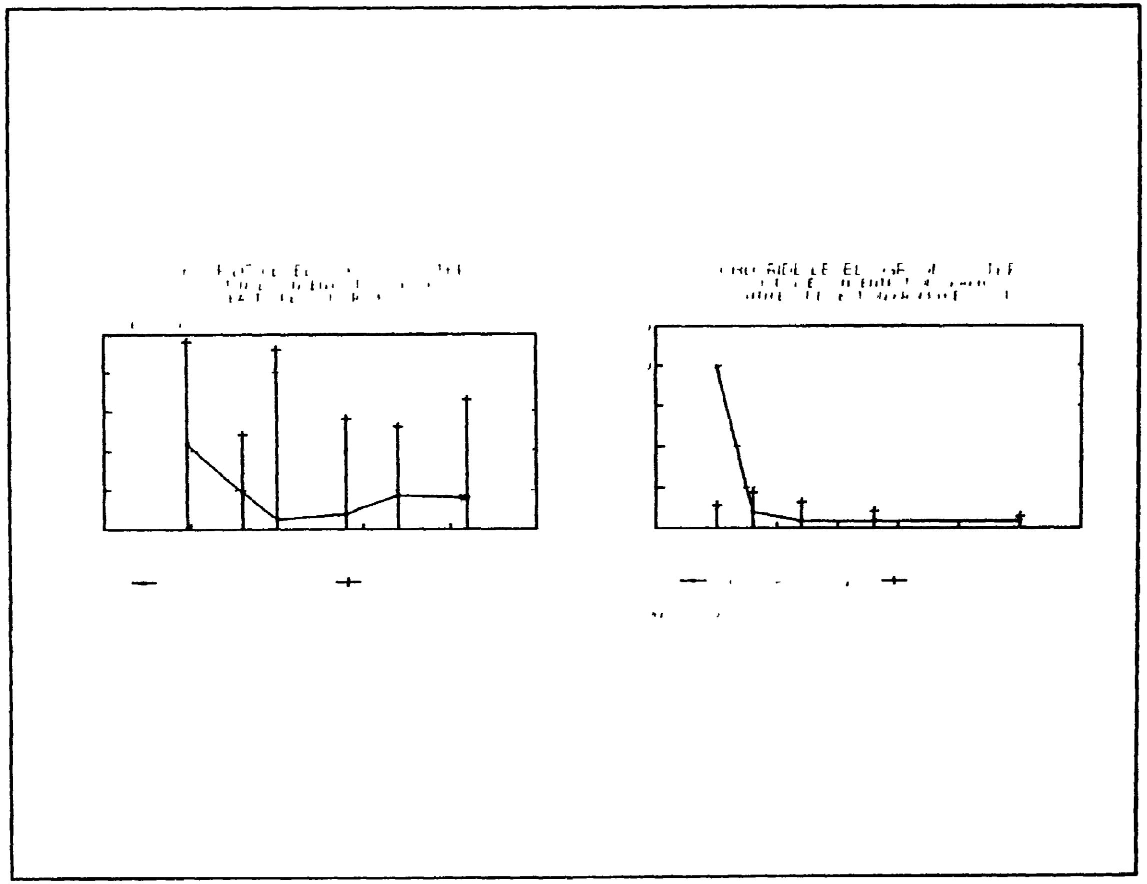
Bacteriological analysis

Total coliform (TC) analysis of GW samples shows a higher value for Block 9 tank, Srimushnam GW and Irumbullikurichi GW i e 2-300, 4-500, and 140-300 MPN/100 ml. While for all other samples the value ranged from 1 to 4 MPN/100 ml, little above the limits This is due to the disinfection of potable water being not carried out.

Salination and sea water intrusion

Analysis of ground water samples collected in zones of sea water intrusion shows a chemical composition differing from a simple proportional mixing of sea water and ground water. In order to avoid mistaken diagnosis of sea water intrusion as evidenced by temporary increase of total dissolved solids, chloride-bicarbonate ratio is recommended as a criteria to evaluate intrusion the ratio of which should be less than 1. The chlorides to bicarbonate ratios were calculated. For most of the wells the ratios were in the range of 0 20 to 0.67 except for one well SAL-8B for which the ratio showed a high value of 1.094 Table 3.12 shows the ratio. Concentration-distance diagrams (Figure 3.17) were also plotted indicating the variation in the chloride levels with distance, the distance measured by taking sea coast as the base i.e " 0 km". The plots were drawn covering two directions separately namely, the north east and the south east directions. It can be seen from the plots that the gradient is more steep in the south east direction while more gradual in the north east. This also suggests that the interface, lies at relatively greater depths for these locations. However, the present tests show the concentration ratios less than 1, and hence do not give an indication of sea water intrusion.

Figure 3.17. Sea water intrusion - distance Vs. concentration diagram



The study done by National Geophysical Research Institute on "Isotope studies of Neyveli Ground water basin" in 1993 was referred to obtain Isochlores for the entire region (Figures 3.18 and 3.19), which reveals that the chloride concentration is relatively higher in 1991, than that in 1985. The contour spacing has also become narrower to that of 1985. The 1985 contour shows low chloride concentration i.e 15-20 ppm in recharge area, about 20-40 ppm in the mine area, still higher concentration in the south or south-east of the mine area and slowly increasing towards the discharge area where values move upto 200 ppm. These isochlores are drawn mainly for upper confined wells During 1991, great change has been observed in both north east and south east directions. The chloride concentrations have increased a lot in the wells located in the above two directions. This change indicates change in geohydrologic regime. The causative factors as identified by the study could be industrialisation in the NE and ground water mining in and around Neyveli and locally both for lignite excavation and agricultural purposes.

In order to further confirm this rapidly changing regimes in the south east and north east portions of the study area, it is very essential to carry out further studies and collect periodical water samples from the identified locations. The study should be carried on time series basis in order to capture the changing patterns which could be then related to the confirmed causative factors.

Table 3.12. Sea water intrusion (concentration ratio calculation)

Station	pH	Depth (m)	Alkalinity	Chlorides	Concentration ratio
SAL 8A	8.3	300	152	81.2	0.53
SAL 8B	8.2	200	148	162.4	1.094
SAL 9	7.6	300	182	52.9	0.30
SAL 12	8.0	300	177	119	0.67
NRO 16	7.9	160	198	113.3	0.57
SIPCOT	6.4	180	192	57.6	0.30
Portonovo east	7.2	440	370	189.8	0.51
Vadalur	6.3	160	182	35.4	0.20

Note: Concentration ratio = [Chlorides/(bicarbonates + carbonates)]
Also note that all the readings are in mg/lt.

3.2.2.4 Ground water quantity

To understand the present ground water situation in the master plan region a historical review is necessary. Since 1956 a lot of wells have been drilled to use the artesian ground water for irrigational purposes and water supply. The maximum artesian outflow has been observed in 1960-61 with 63 mcm. Due to the ground water pumpage in the mining area this amount became less and less and is now negligible. On the other hand the ground water pumpage increased continuously. Starting with about 18 mcm in 1956 the total amount now has reached a value of about 70 mcm.

Ground water is used for water supply to Neyveli township and for industrial units around Neyveli town. The water supply pumpage started in 1961 (2 mcm) and has increased to 21 mcm/a in 1994. The amount of ground water pumped out for industrial units increased from 1 mcm in 1962 to 16 mcm in 1994.

With SIPCOT region another industrial centre belongs to the master plan area. Compared with Neyveli the pumpage is relative small but not negligible. This pumpage (about 8 mcm/a) and the irrigation pumpage is mainly responsible for ground water lowering in the coastal area around SIPCOT, as depicted in Figure 3.20.

Figures 3.21 & 3.26 and Table 3.13 shows the development of pumpage from 1957 till 1993 (the pump rates for 1994 are not known yet).

Figure 3.18. Isochlores based on Chloride concentration of deep ground water (1985)

Figure 3.19. Isochlores based on Chloride concentration of deep ground water (1991)

Figure 3.20. Extraction of ground water for various purposes in the study region

Figure 3.21. Artisian outflow from ground water

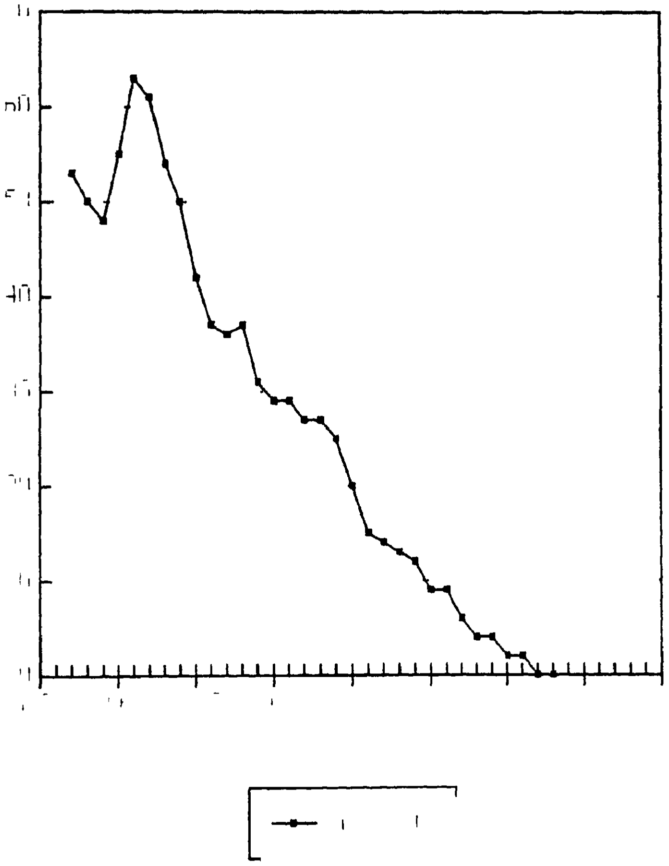


Figure 3.22. Pumpage for irrigation from ground water

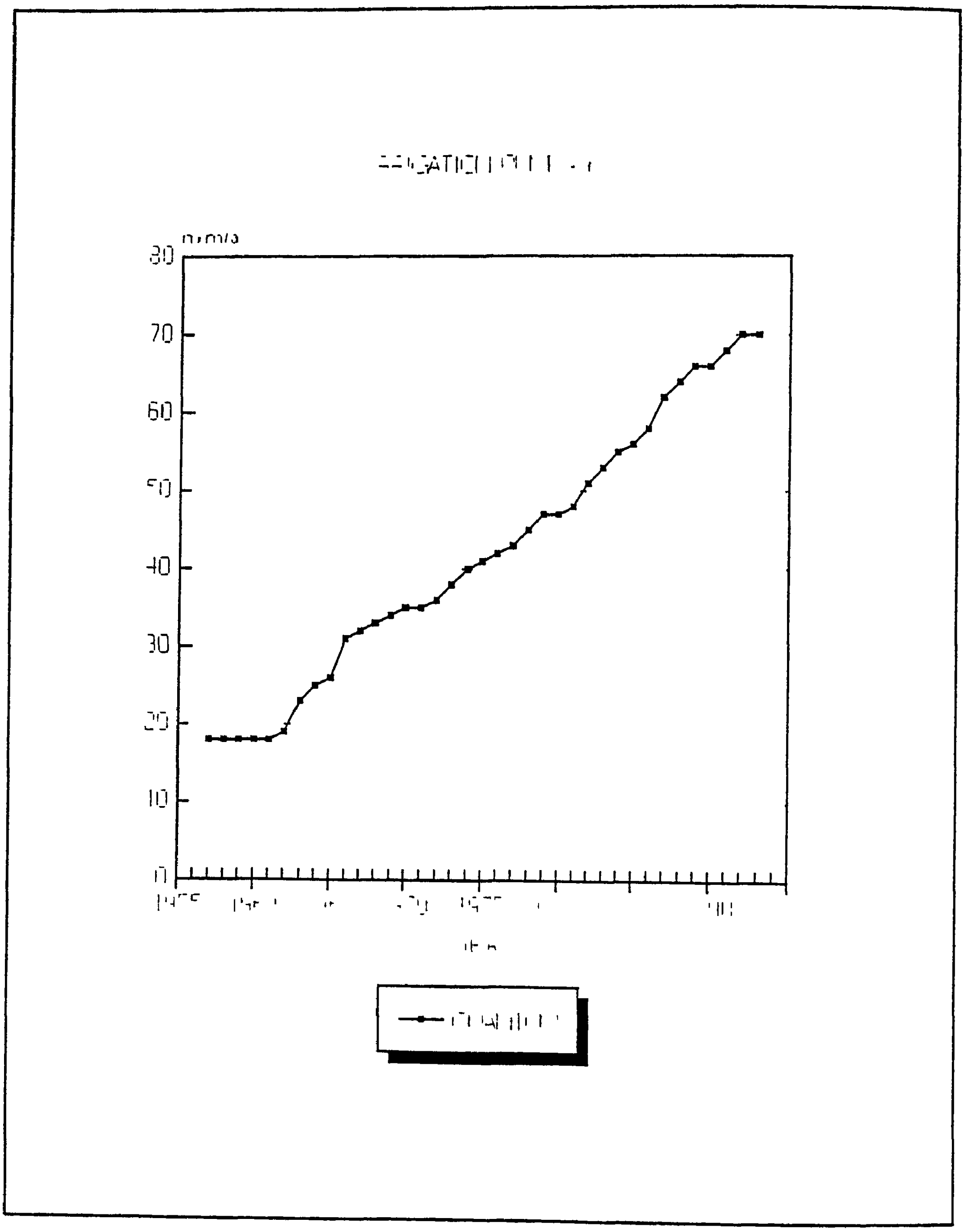


Figure 3.23. Mine pumpage of ground water

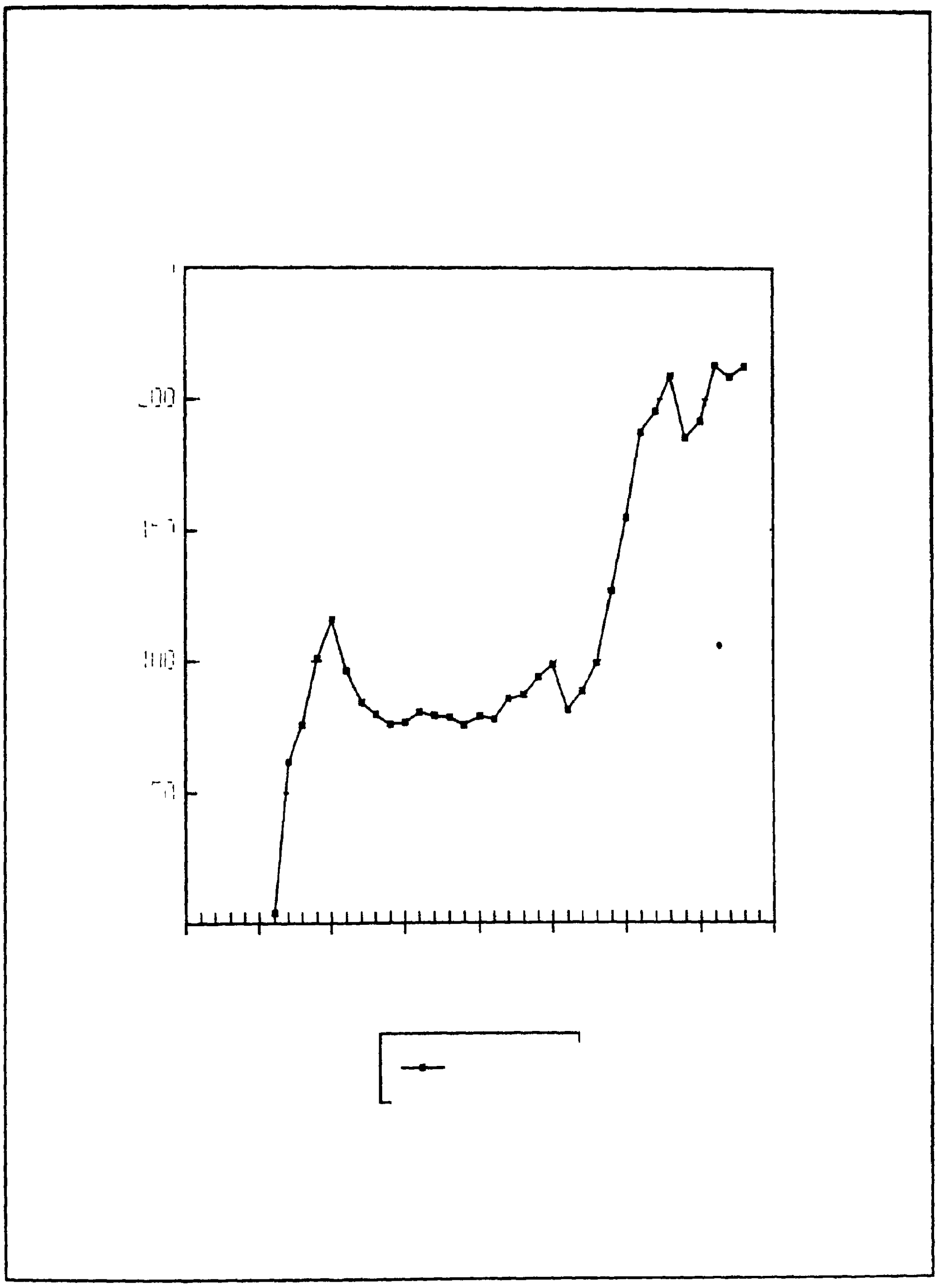


Figure 3.24. Ongoing industrial usage of ground water

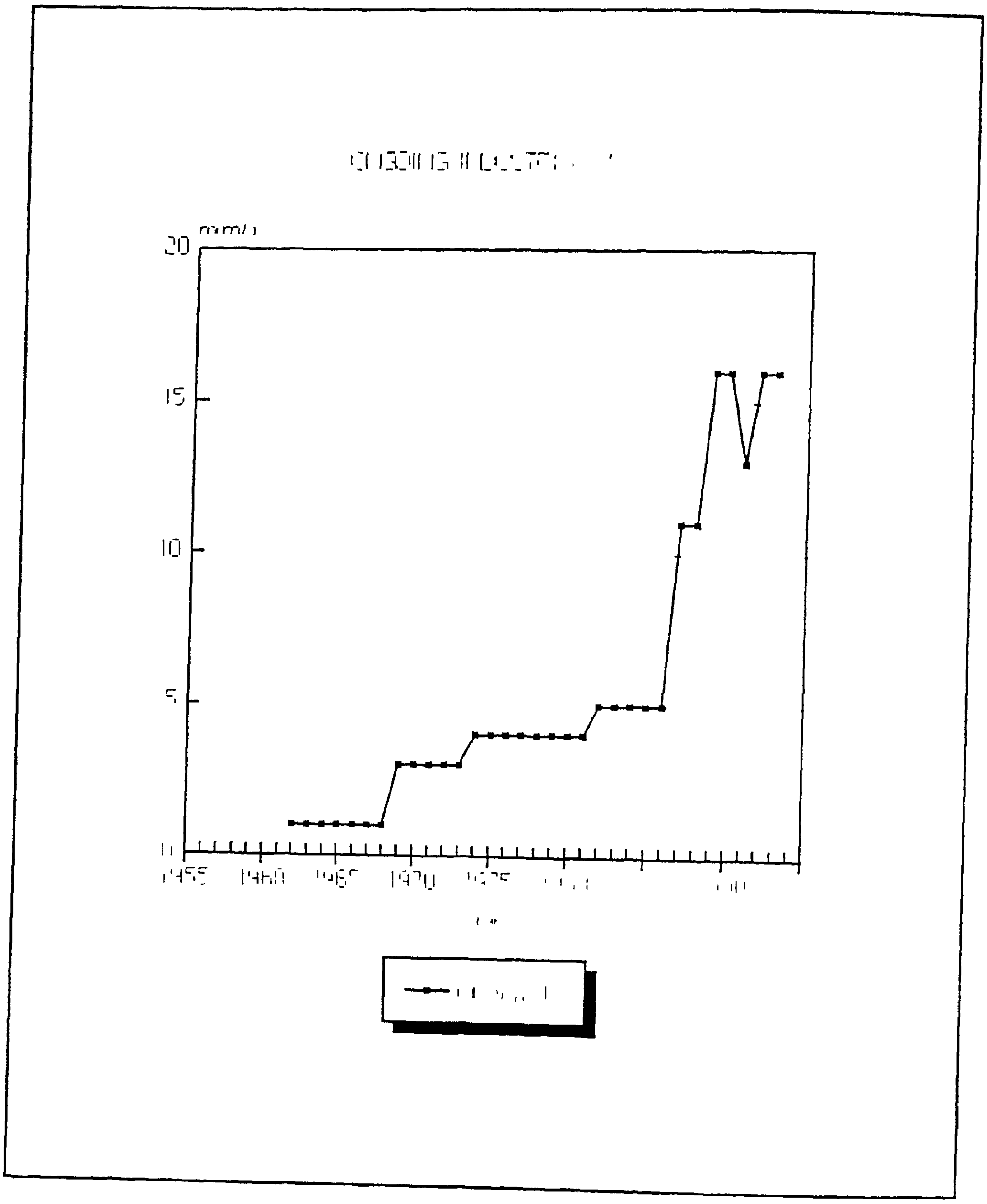


Figure 3.25. Water supply to Neyveli township from ground water

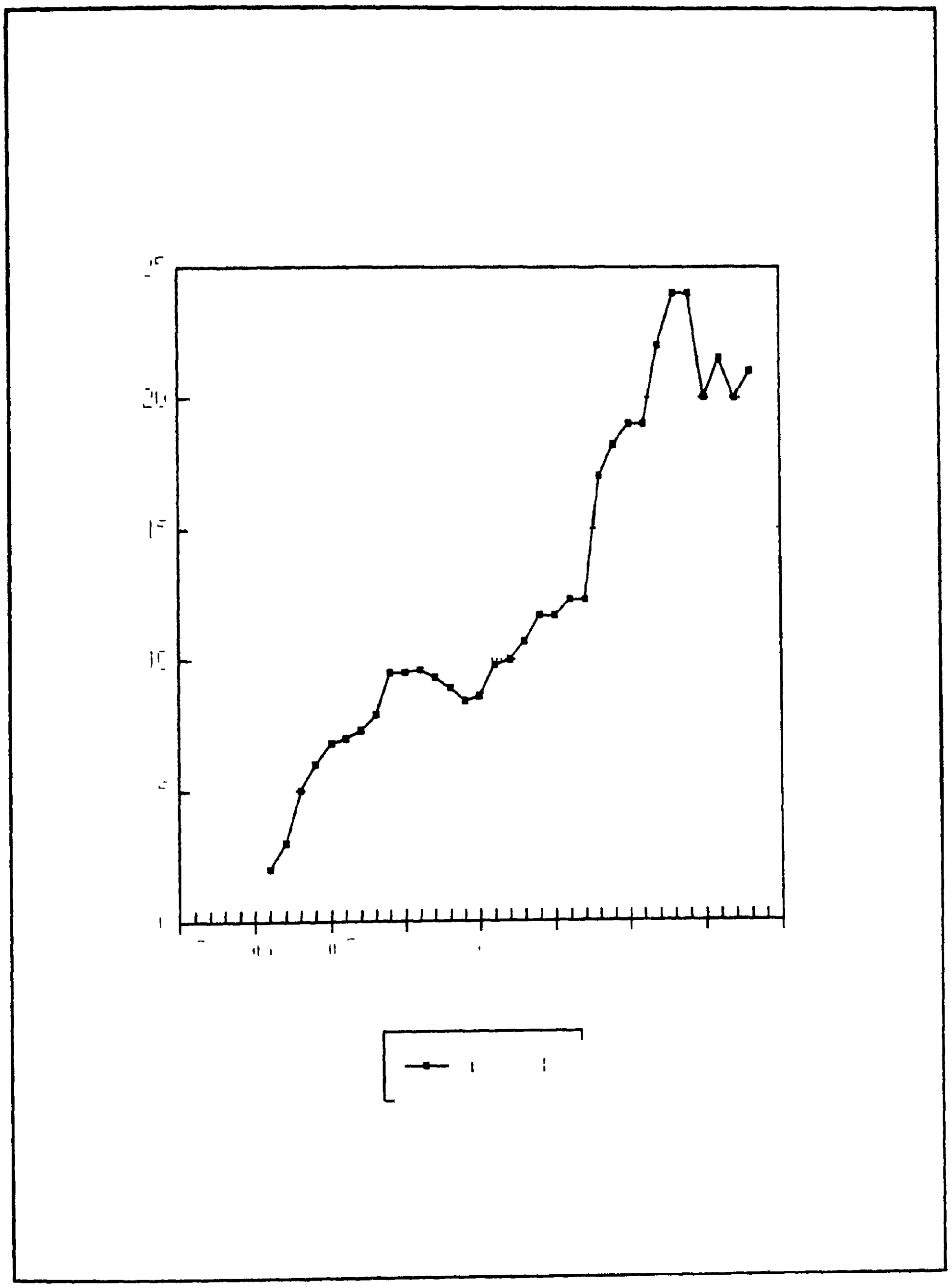


Figure 3.26. Cumulative graph of total output quantities of ground water

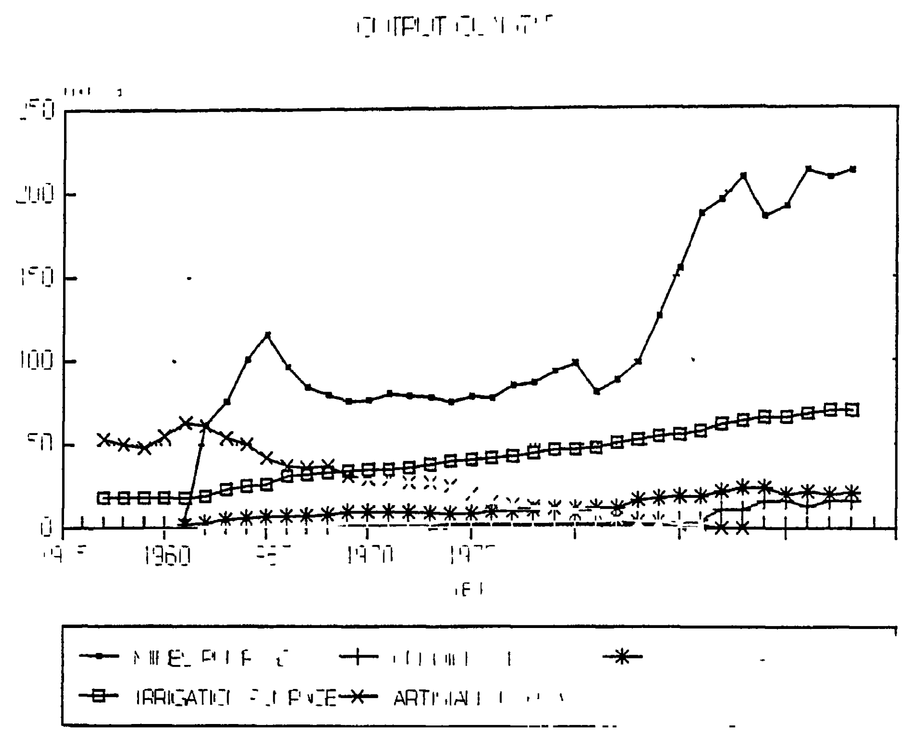


Table 3.13. Ground water balance in Neyveli 1957 to 1993

Year	Total overflow (mcm/a)	Average recharge (mcm/a)	Balance (mcm/a)
1957	71	167	96
1958	68	167	99
1959	66	167	101
1960	73	167	94
1961	86.8	167	80.2
1962	145.6	167	21.4
1963	158.6	167	8.4
1964	182.8	167	-15.8
1965	191.6	167	-24.6
1966	172.1	167	-5.1
1967	160.3	167	6.7
1968	158.2	167	8.8
1969	153.2	167	13.8
1970	152.9	167	14.1
1971	156.9	167	10.1
1972	154.2	167	12.8
1973	155.1	167	11.9
1974	152.7	167	14.3
1975	152.3	167	14.7
1976	148.4	167	18.6
1977	156.3	167	10.7
1978	159.6	167	7.4
1979	168.4	167	-1.2
1980	170.1	167	-3.1
1981	154.6	167	12.5
1982	162.8	167	4.2
1983	178.1	167	-11.1
1984	209	167	-42
1985	236.9	167	-69.9
1986	271.2	167	-104.2
1987	290.5	167	-123.5
1988	307.8	167	-140.8
1989	291.3	167	-124.3
1990	293.6	167	-126.6
1991	315.2	167	-148.2
1992	314.5	167	-147.5
1993	319.5	167	-152.5

Compared with the ground water recharge in the Recharge Area (about 167 mcm/a) the ground water balance became more and more negative during the last 30 years. Table 3.14 and Figure 3.27 illustrate this. Because of this increasing pumpage the ground water levels (pressure heads) in the region became lower, even in recharge area this effect has been observed. For instance, at observation well RO/4 the ground water pressure head has been reduced by about 25 metres within the last 27 years (refer to Figure 3.28).

Including mines pumpage the following actual ground water balance figures can be given :

recharge due to rainfall :	+ 167 mcm/a
inflow south-west (Coleroon):	+ 8 mcm/a
mines pumpage :	- 212 mcm/a
water supply township :	- 21 mcm/a
industrial units:	- 16 mcm/a
irrigation:	- 70 mcm/a
industries in Sipcot:	8 mcm/a

The actual deficit is 152 mcm/a.

Table 3.14. Ground Water Extraction in the study area (till 1993)

Year	Mines pumpage (mcm/a)	Ongoing Ind Units (mcm/a)	Water supply, Neyveli (mcm/a)	Irrigation pumpage (mcm/a)	Artesian outflow (mcm/a)
1957	-	-	-	18	53
1958	-	-	-	18	50
1959	-	-	-	18	48
1960	-	-	-	18	55
1961	3.8	-	2	18	63
1962	61.6	1	3	19	61
1963	75.6	1	5	23	54
1964	100.8	1	6	25	50
1965	115.8	1	6.8	26	42
1966	96.1	1	7	31	37
1967	84	1	7.3	32	36
1968	79.3	1	7.9	33	37
1969	75.7	3	9.5	34	31
1970	76.4	3	9.5	35	29
1971	80.3	3	9.6	35	29
1972	78.9	3	9.3	36	27
1973	78.2	3	8.9	38	27
1974	75.3	4	8.4	40	25
1975	78.7	4	8.6	41	20
1976	77.6	4	9.8	42	15
1977	85.3	4	10	43	14
1978	86.9	4	10.7	45	13
1979	93.7	4	11.7	47	12
1980	98.4	4	11.7	47	9
1981	81.2	4	12.3	48	9
1982	88.5	5	12.3	51	6
1983	99.1	5	17	53	4
1984	126.8	5	18.2	55	4
1985	154.9	5	19	56	2
1986	187.2	5	19	58	2
1987	195.5	11	22	62	0
1988	208.8	11	24	64	0
1989	185.3	16	24	66	0
1990	191.6	16	20	66	0
1991	212.7	13	21.5	68	0
1992	208.5	16	20	70	0
1993	212.5	16	21	70	0

Figure 3.27. Ground water balance in the study area upto 1993

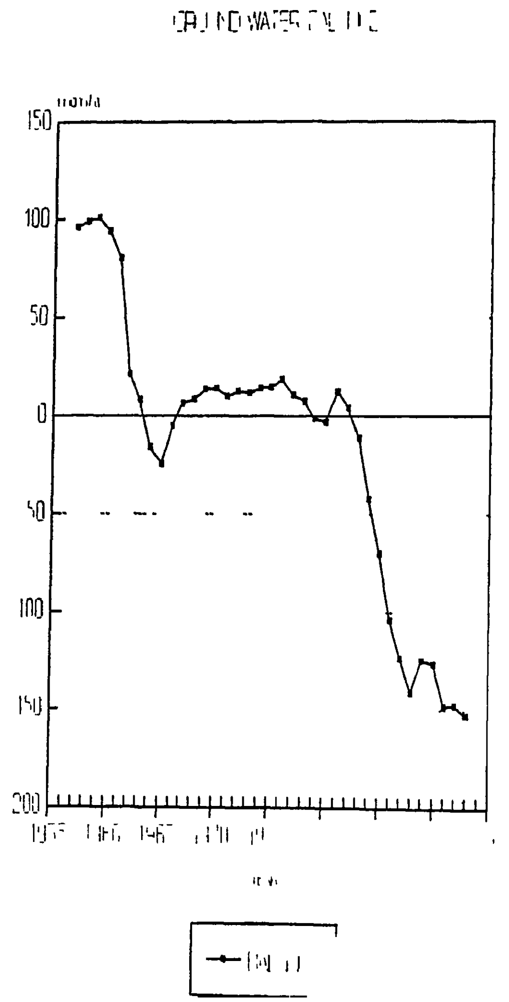


Figure 3.28. Ground water level for RO-4 well

3.2.3 Soil

3.2.3.1 Soil types and characteristics

The soils in this region mainly are red and lateritic in nature. In the red soils the pH generally varies from 6.5 to 8.0. They are generally poor in nitrogen, phosphorous and humus. The pH of lateritic soil varies between 5.4 6.7. The lateritic soils contain very little silicate minerals, but are mostly dominated by hydrous oxides of iron and aluminium. The lateritic soils are very poor in almost all plant nutrients. The main component of clay minerals in lateritic soil is Kaolinite which is a 1:1 type of clay mineral with limited exchange sites. These soils generally possess low cation exchange capacity, and are low in soluble salt concentration. The organic matter content in these soils is generally low except for reclaimed soils due to extensive application of organic manure from external sources as well as accumulation of organic matter due to afforestation programmes.

3.2.3.2 Soil sampling and analysis

A survey was carried out to determine the fertility status of the soils in the study area. The various factors that play vital role in soil quality variations are the land use pattern, ongoing industrial activities, cropping pattern and irrigation practices. For the study considering these influencing factors 17 sites falling under five broad categories of land use given below were selected after consulting with NLC officials. Out of these 17 stations, 12 were in Neyveli area, 2 in Jayamkondam and 3 in Bahour area. The location of soil sampling sites are indicated in Figure 3.29. The details of the sampling sites are given in Table 3.15.

Figure 3.29. Location of soil sampling sites

Table 3.15. Soil sampling locations - category wise break-up

Category	Neyveli	Jayamkondam	Bahour
Agricultural lands	Near Perumal Eri, T V Puttur, Vadakavellur, Muthukrishnapuram	Kallathur	Kuttiyankuppam Sedarapet
Plantation/Afforestation Areas	Afforested area near NLC gate		
Reclaimed Soil	Mine I Reclaimed land		
Premining stage	Mine I Mine II Mine III (Sathapadi) S.Vellar Mine (Nachiarpet)	Suryamannar	Bahour
Overburden Dump	Mine I OB dump Mine II OB dump		

Method of soil sampling

Collection of surface soil samples was done for each of the places listed above in three seasons (June '94, September '94 and December '94). In each place five different locations were selected based on the differences in color of the soil, cropping pattern etc. For each location about 15 spots were fixed randomly in a zig zag manner to represent the entire area taking care to avoid sampling near field bunds, wet places, trees, roads, drainage ditches etc. In each spot surface litter & stones were scraped away by using a spade. Soil was given a 'V' shaped cut up to 6 inches and the soil inside the pit was removed. Then a slice of the soil (of one inch thickness) from both the sides of the pit was collected in a pan. The soil collected in this manner from 15 spots was mixed thoroughly on a plastic sheet and the required quantity of the soil was taken out by adopting quartering technique. Soil from other locations in a place were collected in the similar way The soil thus obtained from five locations for a place were mixed thoroughly and sample for the place was taken by quartering technique. This procedure was followed to collect the representative samples for each of the places selected.

The samples thus collected were dried under shade, ground using wooden pestle and mortar(taking care to break only the aggregates but not the sand and gravel particles) and passed through a 2 mm sieve to obtain the fine earth which was stored in plastic cover for further analysis.

Analysis of samples

The soil samples were analysed for texture, p^H, Electrical condutivity(EC), available forms of Nitrogen, Phosphorus, Potassium, Zinc, Iron, Copper, Manganese and Cation Exchange Capacity by following standard methods.

Particle size analysis

The particle size analysis for soil was done by following the international pipette method as outlined by Piper.

pH

The pH of the soil-water suspension (1:2.5) was estimated by potentiometric method by using Elico pH meter.

Electrical Conductivity (EC)

The EC of the soil-water extract was determined by using electical conductivity bridge (Elico-Solu bridge)

Organic Carbon

The organic carbon content in soil was estimated by following " Walkley and Black Rapid Titration" method. This involves treating soil with excess amount of Potassium dichromate to oxidaize organic carbon in soil to CO_2 in the presence of Conc H_2SO_4. The excess dichromate unused in oxidation is determined by back titration with Ferrous ammonium sulphate in the presence of NaF/H_3PO_4 and diphenyl amine as indicator. The volume of $K_2Cr_2O_7$ used for oxidation is used for calculating the organic carbon in soil

Available Nitrogen

Available N in soil was estimated by using alkaline potassium permanganate method as outlined by Jackson

Available Phosphorus

As the pH values of the soil samples were acidic to neutral, for determination of available Phosphorus Bray's 1 method was followed. Available P in soil was extracted with Bray's 1 extractant, treated with ammonium molybdate and reduced by stannous chloride to develop colour The P concentration was estimated spectrophotometrically

Available Potassium

The available K, viz the sum of water soluble and exchangeable K, was determined by extracting soil with neutral normal ammonium acetate solution. The K present in the extractant was determined by flame photometry.

Determination of micronutrients

The available forms of Zn, Fe, Cu and Mn were extracted with Diethylene triamine penta acetic acid(DTPA). The concentrations of these elements in solution were determined by atomic absorption spectrophotometry.

3.2.3.3 Results and interpretation

The following table gives the average values of parameters analysed for three seasons.

Table 3.16. Soil testing results - category wise

Samples	pH (1:2.5)	Electrical Conductivity d S m^{-1}	Organic Carbon %	Available N Kg/ac	Available P_2O_5 kg/ac	Available K_2O kg/ac
Agricultural lands	7.20	0.16	0.46	102	6	116
Plantations	5.10	0.06	0.31	86	3	74
Premining Situation						
Neyveli	6.80	0.10	0.48	101	6	97
Jayamkondam	6.10	0.07	0.31	85	5	77
Bahour	7.80	0.23	0.36	95	7	270
Reclaimed Soil of Mine I	6.00	0.05	0.76	127	7	50
OB Dumps	7.20	0.07	0.22	74	8	48

Interpretation of the results for each category of soil in the study area is given below.

Agricultural land soils

The pH of the soil was neutral with low soluble salt concentration. The contents of organic carbon and available nitrogen in the soil were considered to be low where as the soil recorded a medium value for potassium. The soil was having sufficient amounts of the micronutrients studied except copper.

Plantations/afforested land

The soil was acidic with very low soluble salt concentrations. The content of organic carbon was low with low nitrogen. Available potassium status in soil was considered to be medium. The available forms of zinc and copper were low in soil but iron and manganese were present in sufficient amounts.

Premining situation

Neyveli

The premining soil of Neyveli was neutral with low salt concentration. The contents of available nitrogen and phosphorus were found to be low The content of potassium in soil was medium. All the micronutrients studied were sufficient for plant life.

Jayamkondam

The soil was acidic with very low salt concentration. Organic carbon content, the available forms of nitrogen, phosphorus and copper were in deficient amounts

Bahour

The soil was neutral with normal salt concentration. The soil was having sufficient amounts of Potassium among major nutrients and Iron, Copper and Manganese among micronutrients studied The contents of nitrogen, phosphorus and zinc were low.

Reclaimed soil

The soil was acidic with very low salt concentration The content of organic matter was high and the available nitrogen status was considered to be medium. the contents of available phosphorus, potassium and copper were inadequate

Overburden dump
The overburden dump was having neutral pH with very low salt concentration. The overburden was found found to be deficient in major nutrients. Except iron the status of all other micronutrients was considered to be inadequate.

The detailed results of analysis of soil samples for all the three seasons are given in Annexure 3.6.

3.2.4 Land

3.2.4.1 Land occupation

The major impact of the ongoing activities on the land in the study area is due to mining operations. To a lesser extent, thermal power stations, ash ponds, industries, lignite bunkers, colonies and other infrastrucural requirements also occupy land surface. Till January 1994, a total area has been acquired by NLC for the various activities in the Neyveli area. The details are as under.

Table 3.17. Details of land acquired by NLC so far

No.	Project	Land acquired so far (Ha)
1	Initial schemes - Mine I, TS-1, Fertiliser and B&C	6,082
2	Mine I exp (4.5 - 6.5 Mt)	994
3	Mine I exp (6.5 - 10.5 Mt)	111
4	Mine I railway line diversion	120
5	Mine II (Ph 1 & 2)	1,917
6	Mine II exp	811
7	TS-2	840
	Total	10,775

The village-wise and typewise land acquired (for items 2 to 7) is given in Annexure 3.7

3.2.4.2 Land damage due to mining operations

NLC, since its inception, has so far exploited a total of about 148 Mt and 36 Mt of lignite in Mine I and Mine II respectively till March 1994. This has resulted in damaging 2628 Ha of land. In the process of mining, dumping of overburden in external dumps has affected about 700 Ha of land and about 925 Ha of the excavated area has been back-filled with internal dump. The mine-wise details are as follows:

Table 3.18. Details of land damaged due to mines

Item	Mine I (Ha)	Mine II (Ha)
External dump area	360	330
Internal dump area	175	749
Total excavated area	NA	771 (till April 1992)
Average area affected per year	90	100

3.2.5 Noise

The important noise sources in the Neyveli region are Mine I, Mine II, Thermal Station 1, Thermal Station 2, Process steam plant, Fertilizer plant, Briquetting and Carbonization plant and vehicular traffic. The ambient noise levels in Jayamkondam area are mainly affected by vehicular traffic Paper, steel, and ceramic industries are the major contributors of noise in Bahour region Noise not only disturbs sleep, interrupts conversations and creates stress and annoyance in the general population but also reduces the efficiency and output of workers. Noise source, transmission path and the receptor are the three basic elements which are involved in all noise problems Proper identification and characterization of noise at various sources are required to develop the appropriate environmental assessment and to evaluate possible mitigation measures.

3.2.5.1 Noise level measurements

A total of thirty sampling stations were selected out of which twenty four stations are located in Neyveli area, and three each in Bahour and Jayamkondam areas. The stations were selected from the four categories namely industrial, commercial, residential and sensitive as prescribed by the Central Pollution Control Board.

Standards

The Central Pollution Control Board has notified the ambient air quality standards in respect of noise (which has been included as an air pollutant under section 20 of the Amended Air Act of 1987). The details are given in Table 3.19.

Table 3.19. Noise standards

Area	Category of area	Limits in decibles, dB (A)	
		Day time	Night time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence zone	50	40

Note:

1) Day time is defined from 6 a.m. to 9 p.m.

2) Night time is defined from 9 p.m. to 6 a.m.

3) Silence zone is defined as areas upto 100 m around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the competent authority Use of vehicular horns, loudspeakers and bursting of crackers are be banned in these zones.

The maximum permissible exposure to different intensities of sound under occupational health and safety for industrial workers are given in Table 3.20.

Table 3.20. Noise exposure limits for industrial workers

Exposure time, hour/day	Limit, dB (A)
8	90
4	93
2	96
1	99
1/2	102
1/4	105
1/8	108
1/16	111
1/32 or less	114

Methodology and equipment used

The measurement of noise in Neyveli, Bahour and Jayankondam areas has been carried out by Integrated Sound Level Meter (model CRL 703 A) manufactured by Cirrus Research Limited, U.K. The Sound Level Meter was kept at 1 2 to 1.5 m above ground level and atleast 3 m from walls, buildings or other sound reflecting sources for outdoor measurement, but indoor measurements have been made at a distance of at least 1 m from walls, 1.2 to 1.5 above the floor and about 1.5 m from the window The measurements were conducted at each station in the morning, afternoon, evening and night periods. The equivalent noise level measured between 6 a m. and 9 p.m has been presented as day noise, whereas, noise level measured at night period has been taken as night noise level. The measurements were taken by setting the instrument at 'A' weighing network as per IEC standard 651 in all the cases.

The whole study was conducted for a period of 2 months from 1.10.94 to 30.11.94 and measurement was done on 3 different days in each station.

3.2.5.3 Results of noise monitoring & analysis

Ambient noise level

The ambient noise levels measured at the various stations in Neyveli, Bahour and Jayamkondam region are given in Table 3.21, 3 22 & 3.23. Detailed date wise results are presented in Annexure.3.8. Existing noise levels in Neyveli region are presented in Figure 3.30. The ambient noise level obtained at the various industrial locations namely east, west, north and south direction of mine 2 and thermal station 2, and entrance of thermal station 1 in Neyveli region was found to be lower during day (55 to 68 dB) and night period (53 to 66 dB) than the standard prescribed by CPCB for industrial area (75 dB for day and 70 dB for night). The noise level monitored at different sensitive locations in Neyveli namely Church (Block-24), hospital (Block-6), dispensary (Block-19 and 8) and ash pond lake of Thermal Station-1 was observed to be varying from 53 to 56 dB for day and 43 to 45 dB for night period and it was marginally higher than the prescribed standard of CPCB for sensitive area (50 dB for day and 40 dB for night). The noise level measured at Material Management Complex which is located at about 500 m. away from the entrance of Thermal Station-1 was observed to be lower in both day (58 dB) and night period (51 dB) than the prescribed CPCB standard for commercial area. Although the material management complex, Church (Block-24) and dispensary (Block-29) are situated within 2 km. from boundary of mine-1, thermal station-1, fertiliser and briquetting plant, but proper positioning of external overburden dump around mine-1 which is completely blocking the township from mine-1 and the creation of green belt around mine-1 and thermal station-1 keeps the noise level of the township considerably low. As sensitive places are situated on the road side of Neyveli township, vehicular traffic on the road increases the noise level in these sensitive areas The ambient noise level has also been monitored at Nadukuppam, Sattamangalam, Vadalur, Erumbur and South of Vellar in Neyveli region to generate the data of background noise level and was observed to be lower during day and night period than the prescribed standard of CPCB for residential area.

Table 3.21. Ambient noise level at the various stations in Neyveli area

Station No.	Station name	Day (leq) dB(A)	Night (leq) dB(A)
N 1	Church (Block 24)	53	43
N 2	Hospital (Block 6)	56	44
N 3	Dispensary (Block 29)	53	45
N 4	Dispensary (Block 8)	54	43
N 5	Material management complex	58	51
N 6	Nadukkuppam	51	43
N 7	Sattamangalam	52	45
N 8	Vadalur	50	43
N 9	Erumbur	53	42
N 10	South of Veller	52	41
N 11	Ash pond lake (TS-1)	51	45
N 12	TS-2 (East)	60	58
N 13	TS-2 (West)	59	54
N 14	TS-2 (North)	57	54
N 15	TS-2 (South)	55	53
N 16	Mine II (East)	61	57
N 17	Mine II (West)	63	62
N 18	Mine II (North)	57	56
N 19	Mine II (South)	68	66
N 20	TS-1 (Entrance)	61	58

Table 3.22. Ambient noise level at the various stations in Jayamkondam area

Station No.	Station name	Day (Leq) dB(A)	Night (Leq) dB(A)
N 25	Jayamkondam	58	49
N 26	Gangaikonda Cholapuram	56	45
N 27	Irumbullikurichi	51	42

Table 3.23. Ambient noise level at the various stations in Bahour area

Station No	Station name	Day (Leq) dB(A)	Night (Leq) dB(A)
N 28	Bahour town	54	46
N 29	Pillaiyarkuppan	52	44
N 30	Thiruppanampakkam	50	43

Figure 3.30. Existing noise levels in Neyveli area

Figure 3.31. Locations of noise monitoring station

Table 3.24. Noise exposure level at the various sources in Neyveli area

Source No.	Source name	Equivalent level dB(A)	Exposure level dB(A)
N 21	Turbine hall (TS-2)	89	110
N 22	Bucket wheel excavator operator's cabin	80	95
N 23	Drill machine operator's cabin	82	97
N 24	Dozer operator's cabin	87	100

3.2.6 Ground vibration due to blasting

Blasting is an important operation in mines where rocks are broken down into fragments suitable for loading and hauling. Explosive energy, in addition to fragmenting and displacing the rock mass, always creates environmental impacts in the form of ground vibration, air pollution, etc It may also cause damage to surface structure. The problem becomes more acute when blasting operation takes place very close to populated areas.

A study was conducted with the help of National Institute of Rock Mechanics, KGF, Karnataka to observe the present status of ground level vibration in Mine I and Mine II due to existing blasting practices. The study also provides suggestions and recommendations to keep the vibration level within safe limits.

Standards

The damage caused due to ground vibration has been correlated with different parameters like amplitude, acceleration and particle velocity Based on the latest work in India and abroad, safe limits of ground vibration are prescribed in terms of peak particle velocity depending on frequency of ground vibration and the type of structure. Most of the standards are based on threshold values of structural damage.

Table 3.25 shows the standards of United States Bureau of Mines (USBM) which are commonly followed for safe levels of ground vibration. Human response to ground vibration begins at lower level and complaints were registered although the ground vibrations were within the safe limits. Taking into account the type of structures located nearby the investigated mines, safe level of ground vibration was considered to be 12.5 mm/s.

Table 3.25. USBM standards for safe ground vibration

Type of structure	PPV, mm/s	
	f<40 Hz	f>40 Hz
Modern homes, drywall interior	19.0	50.0
Older homes, plaster on wood lath construction for interior wall	12.5	50.0

PPV = Peak Particle Velocity, mm/s
f = Frequency of Ground Vibration, Hz

Structure around the mine

The nearest structures to mine I boundary are the hutments of two villages located in east and south side of mine. One railway track connected to Cuddalore - Vridhyachalam town is also situated nearest to mine I boundary. Both the railway track and the east side village are located within a radious of 300 m from the blast site, whereas, the village situated in south side of mine I was 400 m away from the blast site.

The nearest structures to mine II boundary are the hutments and few buildings in the Mandara Kuppam village and these are situated within a radious of 300 m from the blast site.

Also site office of mine II and the Mandara Kuppam - Valayamadevi road are located within a radious of 500 m from the blast site

Instruments used

Ground level vibration was monitored both in mine I and mine II with three seismographs (two S-6 model, US make; one Blast Mate, Canadian make) and one vibration meter (SMU 31 model, German make). All the seismographs are a powerful and flexible vibration recording and analysis system. Each record furnishes peak values in three orthogonal directions and their vector sum.

Results and discussion

The study of blast vibration was conducted in mine I and mine II from 27.9.94 to 2.10.94. The peak particle velocity was monitored at different distances from the location of blast. Table 3.26 shows the date of vibration test, location of blast, location of sensor, distance, total charge (TC), maximum charge per delay (MCD), scaled distance (SD) and peak particle velocity (PPV).

The PPV monitored at different distances in mine I was found to be higher in many cases than the safe level of 12.5 mm/s. The higher charge per delay seems to be responsible for higher figure of PPV. The relative energy content was also studied for different frequency bands and it was observed that rock/soil cover has a dominant effect on frequency, which was ranging from 5 to 39 Hz. It is known that most of the single and double storey residential buildings have their natural frequencies in the range of 4 to 24 Hz. Therefore, resonant effect due to ground motion is to be taken into account while deciding safe limits of blast vibrations Railway track and the village which are situated within a radious of 300 m in east side from the blast site, needs to be shifted completely before further extension of the mine in east side. The village situated at south side also requires to be shifted as it is 400 m away from the currently moving face.

The study of blast vibration in mine II revealed the lower figure of PPV at different distances than the safe level of 12.5 mm/s as shown in Table 3.26. The relative energy content of vibration wave also remained within the frequency range of 5 - 28 Hz. The presently practiced scaled distance was found to be satisfactory to keep the vibration level within the safe level of 12.5 mm/s

Control of ground vibration

The most practical method of reduction of ground vibration is to control the maximum charge per delay. Delay blasting permits to divide the total charge into smaller charges, which are detonated in a predetermined sequence at specified intervals. As higher figure of PPV was observed in mine I, it needs the reduction of maximum charge per delay to keep the vibration level within safe level of 12.5 mm/s The study recommends the scaled distance of 25 m$\sqrt{Kg}$ for mine I to maintain the safe vibration level As hutments and structures of Mandara Kuppam villlage are situated at 150 m away from mine II boundary, the study recommends the scaled distance of 14.6 m/$\sqrt{Kg}$ for mine II to keep the vibration level within safe limit

Table 3.26. Ground level vibration measured at Mine I and Mine II

Date	Location of blast	Location of sensor	Dist. (m)	TC (Kg)	MCD (Kg)	SD	PPV mm/s
27/9/94	Mine I Top Bench	Same Bench(E)	300	6250	281.3	17.88	3.09
28/9/94	Mine I Surface Bench	Same Bench (South)	170	6250	312.5	9.62	90.3
28/9/94	Mine I Surface Bench	Same Bench (South)	340	6250	312.5	19.23	12.4
2/10/94	Mine I Top Bench	Same Bench(E)	150	4952	312.5	8.49	62.2
2/10/94	Mine I Top Bench	Same Bench(E)	200	4952	312.5	11.31	31.9
2/10/94	Mine I Top Bench	Surface Bench(E)	260.8	4952	312.5	14.75	46.2
2/10/94	Mine I Top Bench	Surface Bench(E)	250.8	4952	312.5	14.14	24.0
30/9/94	Mine II Surface Bench	Same Bench (North)	279	6250	162.5	21.89	4.32
30/9/94	Mine II Surface Bench	Same Bench (North)	335	6250	162.5	26.28	2.98
30/9/94	Mine II Surface Bench	Shift Office (North)	540	6250	162.5	42.36	2.67
1/10/94	Mine II Surface Bench	Same Bench (East)	400	6225	162.5	31.38	3.58
1/10/94	Mine II Surface Bench	Same Bench (East)	450	6225	162.5	35.38	3.58
1/10/94	Mine II Surface Bench	Same Bench (East)	200	6225	162.5	15.69	21.0
1/10/94	Mine II Surface Bench	Same Bench (East)	250	6225	162.5	19.61	4.00

3.2.7 Socio-economic conditions

The study area covers a radial distance of 30 km around each of the proposed master plan Projects of the three lignite fields - Neyveli, Jayamkondam and Bahour. The study area falls in the districts of Pondicherry, South Arcot, Tiruchinapalli, and Tanjavur and covers 52 blocks in these districts. This approximately covers an area of about 6,000 sq km. The socio-economic status is discussed as follows·

1) Demography which includes population, households, etc
2) Acquisition of land for mining and other activities and resettlement of all displaced and affected population.
3) Impact of lowering of ground water table on the population.

3.2.7.1 Demography

The study area covers 49 blocks falling in South Arcot, Tiruchirapalli and Tanjavur districts of Tamil Nadu and 7 blcoks in Pondicherry States. The list of all these blocks is given in Annexure 3 9 The various demographic details of the study area are given in Table 3.27

Table 3.27. Demographic details of the study area

Name	T(rural)	T(urban)	Gr Total	% of T-Population	State (%) (1991)
Total no of villages (blockwise)					
Area	406615 3	26720	433335 3	575 2	429
Households	341228	194978	536206		
T_Popln	1528939	963604	2492543		
T_M_Popln	771991	490650	1262641		
T_F_Popln	756948	472954	1229902		
T-SC	423041	154419	577460	23 2	19 2
M_SC	214618	93870	308488		
F_SC	208423	60549	268972		
T-ST	10453	115312	125765	5 0	1 0
M_ST	5343	37991	43334		
F_ST	5110	77321	82431		
T-Literate	652520	279812	932332	37 4	54 6
M_Literate	426873	156819	583692		
F_Literate	225647	122993	348640		
T-Worker	650731	287116	937847	37 6	43 3
T_M_Worker	442663	243358	686021		
T_F_Worker	208068	43758	251826		
T-Marginal	70446	5476	75922	3 0	0 0
M_Marginal	2645	1193	3838		
F_Marginal	67801	4283	72084		
T-Nonworker	807782	671012	1478794	59 3	56 7
M_Non_work	331486	246099	577585		
F_Non_work	476296	424913	901209		

Note:

1. The main workers are the persons who have worked 180 or more days during last one year period to the date of enumeration.
2. Literate persons are the persons who can read and write with understanding in any language.
3. Non-workers are those who have not participated in economically productive activity during the last one year of preceeding enumeration.

The population density of the study area is about 575 persons/sq km as against the population density of the state of 429 persons/sq.km. The total literates in the study area as the percentage of the total population is 37.4% in comparison to the total literates of 54.6% for the state. The total working and non-working population in the study area is 37.6% and 59.3% against the state figures of 43.3 and 56.7%

The demographic status within 10 km radius (core zone) of the master plan projects in Neyveli and Jayamkondam areas are given in Table 3.28. For Bahour area, it was difficult to assess the data since the villages fall in Tamil Nadu and Pondicherry.

Table 3.28. Demographic profile of core zones (10 km radius)

Particulars	Neyveli		% of total population	Jayamkondam	% of total population
Total number of blocks		20		6	
Total number of villages		106		35	
Area		55244.03		39296.87	
Households		49841		29187	
Population	T	225037		125159	
	M	115289		63511	
	F	109748		61648	
SC	T	54655	24.3	24594	19.6
	M	27911		12559	
	F	26744		12035	
Literates	T	98574	43.9	53598	42.8
	M	66687		35077	
	F	31887		18521	
Workers	T	89979	40	52422	41.9
	M	63795		37064	
	F	26184		15358	
Marginal	T	10631	4.7	7098	5.7
	M	515		191	
	F	10116		6907	
Non-workers	T	124424	55.3	65639	52.4
	M	50976		26256	
	F	73448		39383	

Welfare facilities

99.5% of the villages in the study area are provided with electricity. 36.9% of the villages had biogas plants. A summary of the villages covered by facilities for health and education is given in Table 3.29.

Table 3.29. Summary of health and education facilities in the study area

Particulars	Villages covered (%)
1. Education	
- Primary schools	92.5
- Middle schools	25.1
- Secondary schools	15 6
2. Health	
- Health guide services	46
- Private doctors available	11 2
- Doctors practicing indigenous systems of medicine	27.9

During 1990-91, 8.2% of the villages were affected by Jaundice. 12.8% by Diarrohea, 16% by dysentry and 18 2% by other diseases

Details of some selected blocks in the study area is given in Table 3 30.

Table 3.30. Socio-economic details of some selected blocks in the study area

#	Block	No of villages	Education level			Health			
			Primary	Middle	Secondary	Guide	PHC/ APHC/ HSC	Private Doctors	Dr practicing Indian Medicine
1	Cuddalore	75	66	19	14	51	45	19	8
2	Kunnjipadi	71	68	12	11	34	54	10	16
3	Panruti	44	44	23	14	29	27	10	8
4	Annagramam	55	49	11	9	34	32	17	18
5	Prangipettai	57	54	16	8	45	50	6	10
6	Bhuvanagiri	55	51	16	10	48	53	4	24
7	Komaratchi	89	70	20	12	27	89	3	60
8	Keerapalayam	76	71	22	8	10	43	2	11
9	Kattumannarkoil	76	65	20	10	36	34	7	22
10	Vridhachalam	69	67	19	11	18	35	2	16
11	Nallur	77	76	14	9	24	31	5	39
12	Kammapuram	66	65	20	14	24	58	9	6
13	Mangalur	85	82	13	10	32	53	7	12
	District total	895	828	225	140	412	604	101	250

3.2.7.2. Welfare activities undertaken by NLC in Neyveli area

NLC Ltd has a working strength of 22000 employees. In addition, it is reported that about 40,000 persons are engaged in various contract jobs. For its employees NLC has provided the following facilities.

Area of township - 35 sq km
Total No. of houses alloted to employees - 20,694
Water supply - 302 litre/ capita/ day
Shopping centres - 3
Schools - 35
College - 1
Hospital - 1
Dispensary - 4
Strength of students in school and college - 39,000

In addition there are libraries, reading rooms, theatres, sports statium, community welfare centres, religious institutions and auditorium.

NLC has also taken up development and welfare activities in the perepherial areas. These are:

1. Water supply of drinking water to villages

2. Medical care
   - Conducting periodically village medical camps
   - Conducting polio camps and issuing free calipers and artifical limbs for the needy poor
   - Conducting different immunisation camps where doctors reach children at their door steps
   - Regular well baby clinic once a week where mothers are taught about importance of breast feeding, immunisation, baby care, etc.
   - Free outpatient treatment to all the poor patients and inpatient treatment at nominal charges in NLC hospital
   - Health care programmes for school children.

3. Education
   - Nearly 25% of the seats in the 18 schools of NLC is open to the children from villages around Neyveli. These students are offered free education apart from free supply of uniforms, textbooks, notebooks, footwear, etc at lower classes. Wherever school building in the nearby villages needed additional structural facilities, these are also supplemented by the Corporation, free of cost.

4. Road construction in some villages

5. Support to voluntary society (Neyveli Health Promotion and Social Welfare Society)
   - The society runs two centers exclusively manned by handicapped and destitute in book binding, soap manufacturing, grains, pulses, cereals, cleaned powdered and pocketed to be marketed through a number of small booths located in different parts of the township manned by handicapped
   - An artificial limb workshop is also functioning with the assistance of corporation for manufacturing Jaipur type artificial limbs
   - The Corporation has given all assistance and help to "SNEHA Opportunity School" for the mentally retarded children

3.2.7.3 Land acquisition and rehabilitation

Acquisition of land by Neyveli Lignite Corporation started in 1956 and in the first decade of its operation it acquired a total area of 15023 acres for Mine I (4.5 Mt capacity), TS-1 (600 MW), fertiliser plant, B&C plant and colony. Due to this acquisition of land, about 5000 families in 20 villages were affected. Monetary compensation for land was given to the land oustees and in addition land at the rate of two acres per family was also given. About 10 percent of the displaced villagers joined NLC and became regular employees. About 1600 affected families were rehabilitated at two rehabilitation centres.

In subsequent decades additional land has been acquired for Mine I expansion (4.5 MT to 6.5 MT), Mine II (Phase 1 and 2) and TS-2. In addition more land has been requisitioned/ acquired for proposed Mine I expansion (6.5 MT to 10.5 MT), and railway line diversion and TS-2 expansion. Details of land required and acquired are given in Table 3.31.

Table 3.31. Status of land acquisition for NLC projects and affected population

No	Project	Land reqd (Ha)	Land acquired so far (Ha)	Families				Jobs provided
				displaced	To be displaced	affected	Total	
1	Initial schemes - Mine I TS-I Fertiliser and B&C	6082	6002	NA	NA	NA	5000	500
2	Mine I exp (4 5 - 6.5 Mt)	1030	994	857	180	2740	3777	1702
3	Mine I exp (6 5 - 10.5 Mt) including railway line diversion	780	131	90	320	1500	1910	
4	Mine II	2463	2296	1996	674	2930	5600	
5	Mine II exp	1294	372	90	375	3200	3665	
6	TS-2	860	840	50	-	225	275	
	Total	12509	10635	3083	1549	9245	15227	2202

Employment to displace population

As indicated in the previous paragraph, about 500 persons out of 5000 dispossessed families were provided with employment in the intial stages. At that time there was no provision for employment. But in subsequent years, as part of NLC's land acquisition and rehabilitation policy, providing employment to certain categories of displaced persons, subject to availability, was also one of the criteria to be considered. As per this policy about 1700 persons could be offered employment till 1994, whereas more than 13,500 persons have been dispossessed due to land acquisition. There is also a blocklog of displaced persons to be considered for employment because job opportunity is extended at the rate of one job per one displaced family.

Land acquisition, rehabilitation and resettlement policy

Presently NLC is following the Tamil Nadu State guidelines on LA and R & R activities. The main aspects that are being considered by (which in effect could be considered the rehabilitation package of NLC) the company for displacement, R & R are:

Land acquisition

The routine procedure for land acquisition is being maintained by NLC. The state land acquisition office has put one officer in charge of NLC land acquisition through whom all acquisition is done.

Compensation

The monetary compensation is paid for those persons losing only house, house and land, only land and part of their lands. The value of the land is being assessed by the Revenue Department and the value of the house by PWD (Public Works Department). The land compensation is the most representative free market price of the land on the date of notification under Section 4(1) of the LA Act, duly abstracted by the Land Acquisition Officer from the sales statistics for the past three years collected by him from the registration department. The house value is assessed on the value of materials used for construction and the type of construction and is depreciated according to the age of the structure. In addition, 30% of the above is paid as solatium in consideration of the compulsory nature of land acquisition. Besides the above, an additional sum at the rate of 12% per annum on the entire compensation, accruing from the date of 4(1) notification till the date of award is also paid. Poramboke dwellers are not entitled (as per Act) to compensation, but if they have been living on the land for a long time, they will be rehabilitated as per norms.

Employment schemes

NLC has set aside 60% of the vacancies arising in the unskilled category to be filled in from the persons who are displaced One person per family displaced will be entitled to employment provided he/she comes under the priorities set. Four priorities have been set for employment of the displaced families:

Priority I	Those who have given house
Priority II	Those who have given houses and whole of their lands
Priority III	Those who have given whole of their lands
Priority IV	Those who have given part of their lands

Preference is given to persons under priority III who are graduates. Diploma & ITI (Industrial Training Institute) Certificate holders, only in cases where there are absolutely no persons in the entire village sulbjected to acquisition to come under priorities I or II. Poramboke dwellers are not given employment.

Rehabiliation and resettlement

There is provision for all displaced persons to be resettled in rehabilitation colonies for which land is already acquired from the State This land is normally waste land. The average size of each housing plot being provided is 0.05 acres. The house will be constructed by the displaced persons themselves.

The rehabilitatin centres that have been developed/ being developed by NLC are as follows:

- M Parur and Pudukooraipettai (Mine I scheme)
- Kunankurichi (TS-2 scheme)
- Edaikkal near Ulumdurpet (Mine II scheme)
- Rubanarayananallur near Mangalampet (Mine II scheme)
- Thenkuthu near Vadallur (Mines I expansion scheme)
- Umangalam (Mine II scheme)
- B-2 Block South of Indira Nagar (Mine I & II expansion scheme)
- B-1 Block North of Indira Nagar (Mine I & II expansion scheme)

The facilities provided in teh rehabilitation centres are as follows:

- House site
- Dismantled house materials given free
- Free transport to convey house materials
- Road, water supply, street lighting, schools, teachers quarters, buildings for shop/training centre/ dispensary, etc.
- Plantation
- Construction of low cost houses for SC families under DRDP scheme

Problems faced by the displaced people

The people displaced apart from facing physical disturbance are also experiencing mental and social/cultural changes. To assess the extent of this disturbance and suggest possible solutions to mitigate these, a random survey of villages was made. The village sample included 2-3 villages in each of the following categories.

Villages that
- have been displaced and rehabilitated - Pudueri Rehabilitation Centre, Kattakunankurichi
- are currently being displaced - Parvatipuram, Sanarapalayam
- will be displaced in future - Seplanatham, Uyyakondaravi, Keelakudiyiruppu (JK), Sooriyamanal and Angarayannallur

The villages were asked several questions broadly covering the following issues:
- their experiences in displacement/ resettlement
- knowledge of the project
- knowledge of the compensation and the R & R planned
- attitude towards the officials and the project
- aspirations/ future expectations
- possible solutions to the existing problems.

The following three mains points were commonly expressed by the affected people:

a) the land compensations being given was inadequate and appropriate in comparison to the market value

b) the rehabilitation and resettlement infrastructure beign provided (specifically the plot size being provided) is not adequate

c) that they must be provided with a job in NLC

Problems faced by NLC in land acquisition

Providing employment to lan dlosers has been the main problem in acquisition. Jobs are limited and NLC has set their maximum at 100 jobs per year. The skills of the evictees are also limited. If in a year 100 vacancies are not created - which is the case - the backlog of jobs to be provided is increasing all the time The high level of mechanisation of mines and a very limited wasteage (approximately 100 - 150 persons per year) the company cannot employ large numbers of unskilled persons. Thus they are unable to provide employment to all the displaced persons.

Demands for enhanced compensation for patta lands is another problem. Although, the act applies only to patta land owners, demands for compensation from poramboke land dwellers is causing further delays in land acquisition.

Owing to several problems associated with providing employment, NLC is proposing to revise the employment priorities into the following:

Priority I	Those who have lost houses and their lands (and only marginal farms will be considered for employment)
Priority II	Those who have surrendered their lands only (applicable to small and marginal farmers only).

3.2.7.4 Crop pattern

Rice, pulses, sugarcane, cotton, groundnuts, cashew nuts and gingli are the most important crops within this study area. The principle rice growing areas are in the deltaic belt of Chidambaram and northern portion of South Arcot district. But as one goes inland where rainfall decrease and there is less waterlogging, cash crops like plantains, sugar cane, cashew are grown along with paddy Ragi is concentrated in the poor soil tracts of Udayarpalayam and Vridhachalam taluks. The oil seeds grown are groundnuts and gingli, while coconuts are grown all along the coast. Rice-jowar, bajra-oilseeds zone is associated with the taluks of Udayarpalayam in Trichy district and Kalaikurichi, Vridhachalam and Tirukovilur in South Arcot. In this area of 750-1000 mm rainfall, rice occupies 25-50% of the total cultivated area.

The prices of essential commodities such as rice, dhal, oil, vegetables, etc. are given in Table 3.32.

Table 3.32. Prices of essential commodities in the study region

No.	Product name	Price (Rs/ kg)
1	Boiled rice (common)	7.30
2	Boiled rice (fine)	7.75
3	Raw rice (common)	7.80
4	Raw rice (fine)	9.00
5	Toor dhal	22 00
6	Blackgram dhal	23.00
7	Bengalgram dhal	21.00
8	Greengram dhal	20 00
9	Drychilli	32.00
10	Tamarind	21.00
11	Coriander	18.50
12	Potato	6.00
13	Tomato	5.00
14	Onion (big)	5.00
15	Onion (small)	7.00
16	Ground nut oil	39.00
17	Gingelley oil	35 00
18	Coconut oil	49.00
19	Refined oil	44.00
20	Vanaspathy	44 00
21	Sugar	13.00
22	Jaggery (1 sort)	11.00
23	Salt	1.50

3.2.7.5 Fuel consumption pattern

As the region is mainly agriculture based, biomass fuels are the major source of energy for domestic and commercial purposes. But, there is a variation in the fuel consumption patterns of the rural and urban areas. Data from field surveys and from the fuel depots were gathered to determine the fuel consumption characteristics of the region. LPG and kerosene are the primary cooking fuels in the urban areas, while firewood, agricultural residues and dung cake are the major cooking fuels in the rural area. To assess the fuel consumption pattern in the urban areas, the annual total consumption of LPG, kerosene and firewood was collected from individual dealers in the area.

Surveys were conducted to quantify rural firewood consumption. Three representative villages have been selected from each of the sub-areas. 20 percent of the total households in each village were surveyed using a standard questionnaire. The sample selection criterion were factors such as family size, income range and size of land-holding. The results obtained from the surveys were then extended to all the villages in the three sub-areas. Table 3.33 give the fuel consumption pattern.

Table 3.33. Annual domestic fuel consumption in the Neyveli, Jayamkondam and Bahour sub-areas (units in tonnes) in 1993-94

Fuel type	Neyveli	Jayamkondam	Bahour
LPG	2445.0	145	4560
Kerosene	13548.0	2179	12416
Firewood	115876.5	81919	57744
Agri Residues	55204.5	33558	20550
Dung cake	8350.5	6294	3743
Charcoal	234.0	540	432

3.2.7.6 Industries

Neyveli and Pondicherry areas of the study region are industrially developed whereas Jayamkondam area has no industries. Neyveli area is essentially the power base for region with two big lignite based power stations and also having a few other industries A full list of the industries in the region is given in Annexure 3.10.

3.2.7.7 Social impacts of lowering of ground water table

Storm water control operation of water from the mines has resulted in water being freely available in the areas falling to the East and South-East of the mines. This area has witnessed a change in the cropping pattern towards commercial agriculture, such as sugarcane and paddy. On the other hand, large scale pumping of water mainly from the mines (GWC & SWC) and other sources has resulted in the decline of the water table in the region. In the recharge area (North-West of the mines; 420 sq km area) water levels have declined 10-20m since 1961. In the pressure zone (East of the mines; 1300 sq km area) water levels have declined 15-25 m. The impact of this lowering is significant.

In the pre-mining era, the water table was sufficiently high for dugwells and handpumps to cater to water needs for drinking and for agriculture purposes. However with the declining trend in the ground water level. currently, water can only be drawn from deep borewells using submersible pumps. This has created an imbalance, in village communities, where farmers with limited resources have to depend and pay for the water which otherwise was easily accessible. Currently, farmers are paying one-third of the produce for water (water cess !) to other farmers who can afford to own a deep borewell.

Water quality

In general it has been found that the pH of the ground water is acidic in nature and has a high total coliform number (bacterial indicator). The table below gives the summary of the existing water situation in the study area.

Table 3.34. Water situation in the study area

Particulards	% of villages affected/ benefited
Water	
Without drinking water facility	3 9
Water scarcity	17 2
Water contamination	1 9

3.2.8 Eco-systems - flora and fauna

3.2.8.1 Forests

Most of the study area falls in Cuddalore forest division except Jayamkondam which is under Trichy division. The forests in the area can be grouped into i) coastal forests, eg. Pichavaram reserved forest and ii) inland forests. The factors that decide the forest types are rainfall and moisture, proximity to sea, edaphic factors and biotec influence. According to the classification done by Sir Harry G Champion and S K Seth in their book "A revised survey of the forest types in India", the various types of forests met with in this division are:

Table 3.35. Types of forests present in the study area

Major group	Types
Moist tropical forest	Littoral forests, tidal swamp and TS mangrove forest
Dry tropical forest	Southern dry mixed deciduous forest, dry deciduous scrub, southern thorn forest, southern thorn scrub, southern euphorbia scrub and tropical dry evergreen scrub

Littoral forest
The soil is sea sand often blown and accumulating in low dunes with adequate time, but poor in nitrogen and mineral nutrients. Most of these have been converted into casuarina plantation The most characteristic species is the evergreen but light foluaged casuarina. The forest type occurs in reserve forest of Pichavaram.

Tidal swamp forest
This type is found in portions of Pichavaram reserve forest along the banks of lagoons and in the small islands around the estuary. the small islands are covered with mangrove vegetation. The two major islands declared as reserved forest are Pichavaram and Killai.

Tidal swamp mangrove scrub

This type is found in portions of Pichavaram and Killai reserve forest towards the interior, away from the fringes of lagoons etc in areas, which are inundated only occasionally. This covers a larger area than mangrove forests. It is more or less dense forest of very low average height, often further reduced by niotic agencies. These are large areas containing no tree species but only halophytic plants.

Inland forest

The inland forests can be said to contain three type groups of forests namely tropical dry deciduous forests, tropical thorn forests and tropical dry evergreen forests. However, these types are not well defined and distinct because of intrusion of tropical thorn forest type into the others The soil is generally shallow 0.3 m to 1 m in depth, often eroded and is either red or black cotton.

Plantation

The division contains plantations of cashew, eucalyptus, casuarina and miscellaneous species.

Vegetation Species

The different types of species found in these forests are given below

The Littoral forests consists of plant species *Borasses flabellifer, Anacadium occidentale, Lannia coromandalica, Pandanus tectorius, Opuntia dellenii, Cassia auriculata, Sesuvium portulacastrum, Cyprus arenarius*. These are found in the reserved forests of Kalia, Pichavaram, and the unreserved lands of Kunimedu, Settikuppan, and Pudupattu.

The Tidal swamp forests consists of species *Rhizophora mucronata, R candelaria, Sonneratia apetala Aegiceras corniculatum, Acanthus ilicifolics Dalbergia spinosa*. This type of forests are found in Pichavaram, Pudupattu.

The Mangroove scrub consists of *Avicennia marina, Bruguiera cylindrica, Ceriopsis roxburghiana, Acanthus ilicifolius, Fimbristylis polytrichoides*

The Scrub jungles consists of *Dichrostachys cinerea, Morinda tementosa, Pongamia pinnata, Cassis auriculata, Securinega virosa Borreria hispida*

The Southern dry mixed Deciduous forests consists of *Albizzia amara, A. lebbeck, A. odortissima, Terminalia alata, Anogeissus latifolia, Cassia fistula, Dendrocalamus strictus, Vitex negundo, Rhus mysorensis, Tarenna asiatica, Acalypha fruiticosa, Aristids* spp.

The Deciduous scrub found around the estuary consists of *Albizzia lebbeck, A.amara, A. odoratissima, Ficus spp Chloroxylon swietenia, Canthium spp., Memecylon umbellatum. Heteropogon contortus, Aristida spp, Apluda aristata, Dioscorea pentaphyla, Calycopteris floribunda*

The southern thorn forest consists of *Albizza lebbeck, Acacia leucophloca, Acacia chundra, Acacia ferruginea, Aristida spp, Heteropogon contortus, Acacia penneta, Jasminum spp, Abrus precatoris*

The Southern thorn scrub consists of *Albizzia amara, Azadirachta indica, Maba buxifolia, Lannea coromandallica, Acacia leucophloca, Acacia chundra, Capparis spp, Securinega leucopyrus, Carissa opaca, Aristida* spp.

The Southern Euphorbia scrub consists of *Euphorbia anitquorum, Capparis spp. Cassia auriculata, Barleria buxifolia, Opuntia dilenii, Dodonaea viscosa, Aristida* spp.

The tropical dry evergreen scrub consists of *Albizzia lebbeck, Chloroxylon swietenia, Cassia fistula, Memecylon umbellatum, Chomelina asiatica, Cassia auriculata, Carissa opaca, Xeromphis spinosa, Aristida spp, Hugonia mystax*

Forest management

Between 1924 and 1956, most of the forests in the Cuddalore division were under the Panchayat management. During this period the condition of the forests had deteriorated considerably partly due to distructive methods of exploitation and partly due to mismanagement. Many of the forests, which supported dense forest grwoth formerly turned into open scrub jungle. In 1957, the Cuddalore forest division was reconstituted for rehabilitation of the ex-Panchayat reserve forests. In 1959, the division was bifurcated into two divisions namely North and South. In the next decade, large scale afforestation work was carried out in both the afforestation work was carried out in both the divisions and subsequently in 1968, the two sub-divisions were merged to form Cuddalore division Again in 1974, all cashew bearing areas and most of the other better types of areas fit for planting Eucalyptus were leased out to Tamil Nadu Forest Plantation Corporation (new organisation for managing plantation).

Jayamkondam
The main forests types in this region are as follows;

There is a wide variation in the floristic composition of Tiruchirapalli forest division and vary from place to place The annual rain fall is varied up to 800mm.The dry ever green type of forest is prevalent in this region Udayapalayan and Pudukottai range and in the Manapparai range is the dry deciduous forest is predominant here In the Thuuraiyur range tropical dry deciduous type occurs in this region. The following main types are: 1) Southern dry mixed deciduous forests, 2) Southern tropical dry deciduous scrub, 3) Southern Caranatic umbrella thorn type. 4) Tropical dry ever green forests, 5) Southern sub-tropical hill forests.

1. Southern dry mixed deciduous forests consists of *Albizzia amara, Chloroxylon swietana, Acacia sundra, Bauhunia racemosa, Cassia fistula, Bambusa arundanacia, Zizyphus oenoplia, Santalum album Petrocarpus massupium, Dalbergia paniculata* and *Memecyclon edule* are commonly seen.

2. Southern tropical dry deciduous scrub consists of *Acacia sundra, Zizyphus xylopsus, Dalbergia panicullata.*

3 Southern Carnatic umbrella forests consists of *Acacia latsonum, Alibizzia amara, Chloroxylon swietiana, Cassia spinarium, Zizyphus* spp

4. Tropical dry evergreen forests consists of *Manilkara hexandra, Muniosops elangi, Meme cyclon* are seen.

5. Southern sub tropical hill forests consists of *Cedrela toona, Arto carpus hisguita,Magniferia indica, Eugenia monotana,* .and bamboo spp.

Jayamkondam is also surrounded by many reserve forests (RF) such as Managathy, Vellankurchi, Selva Vandig, Shekadumbus, Kalyana puram and Sendurai RF amounting to 863 Ha within the core area of the proposed mining site. Of the 863 Ha, 200 Ha is under cashew plantations, 474 ha under *Eucalyptus*, 140 Ha under miscellaneous species and the rest of the area is under roads

3.2.8.2 Wild life

Wild life is rather scarce in the area and this is because the forests blocks are small and scattered amidst populous villages. Their degraded vegetation and the general lack of sources of water during summer precludes any wild life worth the name Boars, jackals, monkey, porcupines, mangrove, rats and rodents are abundant in the various forests of the area.

3.2.8.3 Avian fauna

The area is rich in avian fauna. Pariridges, quails, doves, vultures, kites, owls, parakeets, sparrows, weaver birds, mynahs, kingfishers, cattle egrets are very common. Peafowl are found in a few of these. A variety of migratory birds like wagtails, ducks, cranes, stilts, snipes and herons can be seen during the season (October - February) in these parts.

3.2.8.4 Survey of the existing ecosystem

In order to get an estimate of species diversity present, as of now, survey for plant and animal species were undertaken in the proposed mining areas i.e, Bahour and Jayamkondam and in the areas where the activity is continuing as well i.e., Neyveli. The following paragraphs give details of the survey methods and the results obtained from this survey.

a) Vegetation transects
In Managathy forests around Jayakondam, one km long and 10 m wide transects were laid to capture the tree diversity of the area. All the stems above 10 cm diameter at breast height (DBH) were enumerated and the girth were measured. The total basal area was calculated using the formula ;

$$COV=\sum_{1}^{n} =\Pi * r^{2}$$

Where r is the radius of the tree and COV indicates the vegetation cover on the ground.

Quantitative vegetation data could not be accomplished in Bahour and Neyveli as there were no forests. Therefore a list of species found in these areas were prepared for comparison. Though in Neyveli, there were vegetation areas of reasonable size, all of them were man made and the species and stem density are known. Using data on the density of each species found in the forests, Shannon-Weiner Species Diversity Index was calculated using the following formula.

$$H=-\sum_{1}^{n} p_1 \cdot Ln(p_1)$$

Where P_i is the proportion of the ith species of the total sample and H is Shannon-Weiner index.

Diversity index

The Shannon index (H) has been the most widely used index in community ecology. It is based on the average degree of uncertainity in predicting to what species an individual chosen at radom from a collection of S species and N individuals will belong. This average uncertainity increases as the number of species increases and as the distribution of individuals among the species become even. Thus, H has two properties that made it popular measure of species diversity 1)H=0 if and only if there is one species in the sample and 2) H is maxium only when all S species are respresented by the same number of individuals,that is,a perfectly even distrubation of abundances.

The Shannon function which uses natural log, where H is the average uncertainty per species in an infinite community made up of S species with known proportional abudances P1,P2..Pi where Pi are the population parameter.

b) Bird transects

One km long transects were laid in Bahour, Jayakondam and Neyveli regions to capture the avifaunal diversity. Transects were laid in Bahour lake and Osten lake in Bahour region, Managathy forest in Jayakondam region and different habitats such as afforested land, currently mined land, township and overburden areas were undertaken in Neyveli region

In each transect, the birds were observed at every 100 m intervals for five minites in 360 o angle Transects were laid both in morning (between 6 - 9 AM) and evening (3 - 6 Pm) hours in each region There were 16 transects in month covering all the regions. Data were collected over five months and was pooled for each region and Shannon-Weiner Species Diversity Index was computed. Diversity index was computed for data pooled over each month also

c) Fish

Data from various tanks such as Walaja, Perumal, Osteri, Bahour tanks were collected from the Fisheries department. A quantitative data on how much of each species of fish captured during the given year was collected. Using the weight of each species of fish from different tanks, the Shannon-Weiner's species diversity index was calculated.

d) Mammals and other biota

Qualitative assessment for presence and absence of some of the mammals were conducted using indirect clues. We also used information from other literature such as forest working plans, articles from standard refereed journals and books describing the fauna of this area to assess the presence.

e) The presence of various tanks, rivers and estuaries in the proposed mining areas were also listed and attempt was made to take the aquatic fauna in these tanks. However, most of the tanks that were found in Jayamkondam area were seasonal and no aquatic fauna were found during the study period.

f) In order to capture the changes that has taken place around Neyveli, an interview or oral history method of interview with older inhabitants were conducted. Their feelings and change of the landscape as described by them was recorded.

3.2.8.5 Results of surveys

Vegetation

The tree species present at different regions are given in Table 3 36. Vegetation cover at Neyveli is good with 30 species growing in township and mining places. Bahour and Osteri has 11 and 14 tree species respectively Mangathy forest although had better cover but had only 10 tree species. The species diversity index for Managathy forest in 1 Ha area was 1.93 and tree cover of 4168 3 cm^3 This cover is far lower to good scrub forests found in southern India

Table 3.36. List of tree species observed in different study sites

Neyveli	Bahour	Ostteri	Managathy
Acacia arabica	*Tamarindus indica*	*Azaidiricta indica*	*Samanea saman*
Acacia auriculiformis	*Azaidiricta indica*	*Phoenix sylvestrix*	*Azaidiricta indica*
Acacia catechu	*Eucalyptus hybrida*	*Acacia nilotica*	*Tamarundis indica*
Acacia nilotica	*Ficus religiosa*	*Cassia fistula*	*Eugenia jambulina*
Acacia leucophloea	*Delonix regia*	*Samanea saman*	*Zizypus mauritiana*
Agave mexicona	*Acacia arabica*	*Tamarindus indica*	*Pongamia pinnata*
Albizzia indica	*Ceiba pentandra*	*Mangifera indica*	*Albizzia lebbek*
Dendrocalamus strictus	*Eugenia jambulina*	*Peltophorum ferruginae*	*Dendrocalamus strictus*
Eucalyptus hybrida	*Phoenix sylvestrix*	*Ficus religiosa*	*Ficus religiosa*
Grevelia robusta	*Samanea saman*	*Albizzia lebbek*	*Acacia nilotica*
Albizzia lebbek	*Acacia leucophloea*	*Delonix regia*	
Anacardium occidentale		*Ceiba pentandrea*	
Cassia fistula		*Leuceana leucocephala*	
Casurina equisitifolia			
Ceba pentandra			
Cedrela toona			
Dalbergia sisso			
Delonix regia			
Eugenia jambulana			
Legerstroemia flosreginae			
Leuceana leucocephala			
Peltophorum ferrugianae			
Melia dubia			
Parkinsonia areculeata			
Polyalthia longifolia			
Pongamia pinnata			
Pterocarpus marsupium			
Sesbania grandiflora			
Tamarandus indica			
Tectona grandis			
Terminalia arjuna			

Birds

Bird species diversity was high (2.88) with 24 species occurring in Managathy forests (Table 3.37). Neyveli had highest number of (29) species of birds with a diversity value 2.63 Bahour had low bird diversity (2.1) with lowest number of 22 species. Osteri had 28 species of birds with diversity index of 2.72

Table 3.37. Avifaunal diversity at different places in master plan area (+ indicate presence and - indicates absence)

	Neyveli	Osteri	Bahour	Managathy
Hoopee	+	-	+	+
Black drongo	+	+	+	-
Common swift	+	+	-	-
Darter	-	+	-	-
House crow	+	+	+	+
Jungle crow	+	+	+	+
Spotted dove	-	+	+	+
Tickle flower pecker	+	+	+	+
Scarlet minivet	-	-	-	+
Brahminy myna	+	+	+	+
Babblers	+	-	+	+
Red vented bulbul	+	+	+	-
Cattle egret	-	+	-	-
White breasted kingfisher	+	+	+	+
Plain warbler	+	-	+	-
Common sand pipper	-	+	-	-
Pied fly catcher	-	-	-	+
Sun bird	+	+	+	+
Ashy wren-warbler	+	+	-	-
Common sparrow	-	-	+	-
Spotted munia	-	-	-	+
Magpie robin	+	-	+	+
Shama	+	+	-	-
Crimson red barbet	-	+	-	-
Wood shrike	-	-	-	+
Koel	+	-	-	+
Small coromant	-	+	-	-
Yellow fronted wood shrike	-	-	-	+
Green bee eater	+	-	-	-
Pond heron	-	+	-	-
Pied munia	-	-	-	+
Spotted owlet	+	-	-	-
Common wood pecker	-	+	-	-
Small minivet	+	+	+	-
Large cormorant	-	+	-	-
Indian pitta	+	+	+	+
Common bee eater	-	+	-	-
Crow pheasant	+	-	-	+
Common kingfisher	-	-	+	+
Franklin nightjar	+	-	-	-
Brahmini kite	+	+	-	-
Common buschat	-	-	-	+
Parakeet	+	-	-	+
House swift	-	+	+	-
Pariah kite	-	+	-	+
Pied kingfisher	+	-	+	+
Red wattled lapwing	+	+	-	-
Chestnut bee eater	+	-	+	-
Cuckoo	+	-	-	-
Diversity Index	2 63	2 72	2 10	2 88

Aquatic life

Osteri tank had a fish diversity of 1 42 as compared to Bahour 1 88 There was no quantitative data available for other tanks such as Walaja, and Veeranam. The species found in Estuary of Pondichery were milk fish, millets, pearl spot, oxe eye, sea water prawn, white carp, murals, crabs and gourami. The species present in various tanks are Catla, Rohu, Mirgal, Common carp, Murrel, Live fish, Feather backs, Cat fishes, Fresh water prawn, Grass carp, Silver carp Walaja tank had no fishes in it.

The other biota mammals, reptiles and other macro and micro vegetation found in this area are given below;

Mammals

Insectivorous bat, Mongoose, Three stripe squirrel, Jackal, Macaques, Bandicoot, Mouse, Black naped hare

Reptiles

Tortoise, Ground lizard, Snakes

Macro Vegetation found in ponds

1. Floating - *Eichhornia crassipes, Pistia stratiotes, Salvania cucullata, Azolla pinnata*
2. Emergent - *Nymphaea spp, Nelumbo nucifera, Nymphirdes, Cristatum, Trapa hipnosa.*
3. Marginal - *Impomea aquatica, Justiacea oleracea, Neptunia oleracae, Colocasia antiquious*
4. Submerged - *Ceratophyullum demersum, Utricularia* spp

Phytoplankton

1. Green algae - *Chlamdomonas spp, Panandomonas, Morum, Eudorina elegans*
2. Chrysomonads - *Synusauvella and Dinbryon*
3. Diatoms - *Cyclotella, Minghinea, Pinnularia spp*
4. Dinoflagellata - *Peridinium spp, Ceratium hirumdenella*
5. Blue green algae - *Arthrospinear plantis, Anabena spiroides*
6. Euglenincae - *Euglena tuba, Phacus* spp

Zooplankton

1. Rhizopods - *Arcella, Diffugia*
2. Ciliates - *Coleps*
3. Suctoria - *Podophrya*
4. Rotifers - *Polvarthra, Fulinia, Hexarathra*
5. Cladocera - *Daphnia, Cecrodaphnia, Moina*
6. Copepods - *Diaptomus sp, Cyclops sp.*

3.3 Identifying areas of poor environmental quality conditions

On a study of the ambient environmental quality conditions in the area, it is observed that the most important impacts are on land, ground water quantity and displacement population due to acquisition of land for mining and other activities. The ground water level has gone down by 15-25 m during the last 30 years since starting of lignite mining. The problem arises due to ground water pumpage for lignite mining. The water quality in surface water bodies and ground water are well within the prescribed standards for the best designated use. There is an excessive use of water in some industrial units for diluting the effluents before discharge. The air quality parameters are all well within the prescribed standards in the whole of the study area.

Chapter 4. Generation and discharge of pollutants - existing scenario

4.1 Estimating residual generation and discharge of pollutants

The level of economic activity can be expressed in terms of tonnes of product output, electricity generated, freight movement and population in the area. Since the amount of residuals generation is directly dependent on the physical output, residual generation coefficients are expressed per unit of output, i.e. kg of SPM per tonne of mined coal, per kWh of electricity, etc., and can be developed in two ways:

i) by adopting and/ or modifying coefficients found in the literature;
ii) by deriving co-efficients from empirical data collection and analysis.

Both the procedures have been used to estimate these coefficients, the idea being to reflect as closely as possible the actual residual generation in the area. Two co-efficients have been estimated, namely, source generation and discharge. The former represents the generation of residuals per unit of activity by the process, while the discharge coefficient takes into account the control devices installed and therefore reflects the actual discharge per unit of activity. It is useful to disaggregate in the above manner as it permits the evaluation of measures that are aimed at reducing residuals at the process or at the end-of-pipe stage.

4.2 Air pollution

Developing reasonable estimates for source generation and discharge co-efficients was an extremely difficult task since very little actual emission data was available for the area. This problem not only exists for this area, but in general very little actual emission data is available for most activities in India. Therefore, the values that have been developed, don't represent a "robust" estimate but rather a first approximation which was felt as a reasonable estimate for the phenomenon under actual operating conditions.

4.2.1 Neyveli sub-area

4.2.1.1 Mining

Large amounts of SPM are generated in lignite mines from various operations namely excavation and transportation of lignite and overburden, vehicular movement inside the mines, wind erosion from overburden dumps and lignite stockyard. The uncontrolled SPM not only creates health hazard but also affects productivity through poor visibility, breakdown of equipment, increased maintenance cost and deteriorates the ambient air quality in and around the mining site. Water spraying is a common method to control the fugitive dust in mines. But during hot summer days, water gets evaporated fast and the problem of fugitive dust remains.

Estimates for fugitive dust generation from lignite mines (with bucket wheel operations) were not available.

Dust control measures in mines

Mine I
In all the 5 overburden benches and the lignite benches 6" water pipelines are laid along the conveyor and the water which is at 100 psi pressure is used to suppress the dust.

Mine II
Dust suppression in lignite bench and one overburden bench is presently done by automatic sprinkling system laid along the conveyor line Whereas 6 water lorries of capacity 6 kl and one sprinkler of capacity 28 kl are used for spraying water in rest of the benches.

In both Mine I and Mine II cutting teeth of BWE are regularly checked, maintained and replaced to reduce the formation of fugitive dust during cutting operation. Drilling machines in Mine I and Mine II are provided with dust collectors, which regulate the fine dust to be discharged into air in safe distances and safeguards the operators cabin from entering the fugitive dust. As lignite contains higher moisture (40-50%), less amount of fugitive dust emanates while transporting through belt conveyor. Frequent water spraying from automatic sprinkling arrangement on lignite stockyard in Mine I and Mine II prevents the formation of large amount of fugitive dust. Fugitive dust emanates from wind erosion of overburden dumps, takes the downwind path to disperse long distances and causes deterioration of air quality in nearby mining area. So far no quantification is available of fugitive dust emission from overburden dump of Mine I and Mine II. NLC has planted large number of trees in Mine I dump areas to prevent wind erosion.

4.2.1.2 Power

In the power sector, source generation estimates were based on the specific fuel consumption for the individual power plants and the ash content of lignite. Discharge coefficients assumed an average operating efficiency of 90 percent for ESPs and 60 percent for mechanical precipitators. These differ from design estimates which are much higher. However the above figure reflect actual average operating efficiency which include the times when the control equipments were not operating for e.g. during start-up, and during oil-firing, etc. The details of existing dust control measures in the power plants are given in Table 4.1.

Table 4.1. Details of existing control measures in TS-1 and TS-2

Stack details			Type of control	Year of installation
Number	Height (m)	Internal diameter (m)		
TS-1				
1	60	5.1	MDC/boiler 1	1962
			ESP/boiler 2	1991
			ESP/boiler 3	1993
2	60	5.1	MDC/boiler 4	1963
			ESP/boiler 5	1990
			ESP/boiler 6	1992
3	60	5.1	MDC/boiler 7A	1967
			ESP/boiler 7B	1991
4	120	5.1	ESP/boiler 8A	1993
			ESP/boiler 8B	1992
			ESP/boiler 9A	1990
			ESP/boiler 9B	1970
TS-2				
1	170	5.28	ESP	1986 to 1993
2	170	5.28	ESP	
3	170	5.28	ESP	
4	220	4.93	ESP	
5	220	4.93	ESP	
6	220	4.93	ESP	
7	220	4.93	ESP	

Note:

ESP: Electrostatic precipitator
MDC: Mechanical dust collector

4.2.1.3 Industry

The main industries in the Neyveli area are the Fertiliser plant, B & C plant and a Process Steam Plant which caters to the steam needs of the Fertiliser and the B&C plants. All three plants are owned by NLC. The other industries in the area include MRK Sugar mills, Sethiatope and Chemplast India Ltd., Kadampuliyur.

The source generation estimates from process steam plant were based on fuel consumption for lignite and gas and the average annual operating efficiency of emission control equipment (3 MDCs are connected to 3 stacks: design efficiency 80%: average operating efficiency 60%).

The emissions from B&C plant are essentially fugitive in nature and were extremely difficult to quantify.

A rough estimate was made (based on normative estimates) for emissions from the sugar plant. There was no significant air pollution from Chemplast Industries Ltd.

4.2.1.4 Transport

Based on the passenger and freight traffic and estimated fuel consumption emission discharges has been worked out for the transport activities in the area. However, generation of fugitive dust from both passenger and freight movement could not be quantified.

The details of generation and discharge of pollutants for the various activities are summarised in Table 4 2.

4.2.2 Bahour area

4.2.2.1 Industries

The Bahour core area has 7 industries for which emission inventory has been worked out based on one-point stack emission data provided by the Pondicherry Pollution Control Board. The estimates of emission inventory are very approximate and give only a rough indication of the emission load. For industries located in Cuddalore no data on production, emission, etc. was provided by the Tamil Nadu Pollution Control Board (as they declared it as confidential data) as well the individual industries, in spite of our repeated visits to the SIPCOT industrial estate did not give any data. Also traffic flow data was not available for this area.

Table 4.3 shows the present discharges of air pollutants in Bahour area.

4.2.3 Jayamkondam area

There are no industrial activities in this area. Generation and discharge of pollutants from transport sector have been estimated and are given in Table 4.4.

4.2.4 Domestic asd commercial sectors

Emissions from the domestic and commercial sectors have been estimated for the study region as a whole. These have been based on population and the estimated share of different fuels in different areas of the study region. Table 4.4 gives the emission discharge.

Table 4.2. Present generation and discharge of air pollutants in Neyveli area

Source	SPM		SO_2		NO_x		Activity	Discharge (t)		
	Generation co-eff	Discharge co-eff.	Generation co-eff	Discharge co-eff	Generation co-eff	Discharge co-eff		SPM	SO_2	NO_x
Power										
TS-1	84 6 g/kWh	14 8 g/kWh	19 9 g/kWh	19 9 g/kWh	10 g/kWh	10 g/kWh	2372 MkWh	35121	47203	23611
TS-2	68 1 g/kWh	6 8 g/kWh	16 g/kWh	16 g/kWh	8 g/kWh	8 g/kWh	7024.5 MkWh	47856	112392	56301
Industries										
Process steam plant	14 kg/t of steam	5 9 kg/t of steam	3 kg/t of steam	3 kg/t of steam	2 2 kg/t of steam	2.2 kg/t of steam	1 766 Mt of steam	10444	6137	3871
Fertiliser	10 kg/t of urea	10 kg/t of urea	0 7 kg/t of urea	0 7 kg/t of urea	2 kg/t of urea	2 kg/t of urea	0 111 Mt of urea	1110	77 7	222
B&C	*	*	*	*	*	*	0 227 Mt of coke	*	*	*
MRK Sugar	37 89 kg/t of sugar	*	Nil	Nil	25 26 kg/t of sugar	NA	30000 t of sugar	1137	NA	758
Chemplast	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Transport										
Passenger	0 008 g/pkm	0 008 g/pkm	0 043 g/pkm	0 043 g/pkm	0 248 g/pkm	0 248 g/pkm	3023x10^6 pkm	25	131	751
Freight	0 067 g/tkm	0 067 g/tkm	0 354 g/tkm	0 354 g/tkm	2 035 g/tkm	2 035 g/tkm	410 5x10^6 tkm	28	145	835

* - Fugitive emissions, not quantified
NA - Not available.

Table 4.3. Present generation and discharge of air pollutants in Bahour area

Source	SPM		SO_2		NO_x		Activity (t)	Discharge (t)		
	Generation co-eff	Discharge co-eff	Generation co-eff	Discharge co-eff	Generation co-eff	Discharge co-eff		SPM	SO_2	NO_x
Industries										Nil
SIPCOT	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBF Ind	0.236 kg/t of Ethlene	NA	0 005 kg/t of Ethlene	0 005 kg/t of Ethlene	38x10^{-4} kg/t of Ethlene	38x10^{-4} kg/t of Ethlene	16100	3 8	0 081	*Negligible*
East Coast Steel	5 5 kg/ t of Billet	NA	Nil	Nil	Nil	Nil	198000	1089	Nil	Nil
Mittal Ispat	2 975 kg/t of Ingot	NA	0 0086 kg/t of Ingot	0 0086 kg/t of Ingot	0 0083 kg/t of Ingot	0 0083 kg/t of Ingot	20000	59 5	0 172	0 166
Pondi Papers	123 kg/t of paper	NA	2 5 kg/t of paper	2 5 kg/t of paper	Nil	Nil	9000	1107	22 5	Nil
Pondi organics	110 kg/t of Aruline	NA	10 31 kg/t of Aruline	10 31 kg/t of Aruline	75 63 kg/t of Aruline	75 63 kg/t of Aruline	24000	2 6	0.248	1 185
Nycer Ltd	10 26x10^{-4} kg/t of tile	NA	2 73x10^{-4} kg/t of tile	2 73x10^{-4} kg/t of tile	Nil	Nil	20000	Negligible	Negligible	Nil
Silica Metallurgic	0 821 kg/t of ferro silicon	NA	0 0012 kg/t of ferro silicon	0 0012 kg/t of ferro silicon	0 0024 kg/t of ferro silicon	0 0024 kg/t of ferro silicon	3000	2 464	0 003	0 0073

* - Fugitive emissions, not quantified

NA - Not available.

Table 4.4. Present generation and discharge of air pollutants in Jayamkondam area

Source	SPM		SO$_2$		NO$_x$		Activity	Discharge (t)		
	Generation co-eff	Discharge co-eff	Generation co-eff	Discharge co-eff	Generation co-eff	Discharge co-eff		SPM	SO$_2$	NO$_x$
Transport										
Passenger	0 007 g/pkm	0 007 g/pkm	0 039 g/pkm	0 039 g/pkm	0 234 g/pkm	0 234 g/pkm	910 5x10^6 pkm	9	46	270
Freight	0 067 g/tkm	0 067 g/tkm	0 354 g/tkm	0 354 g/tkm	2 085 g/tkm	2 085 g/tkm	27 9x10^6 tkm	2	10	57

Table 4.5. Emissions from domestic and commercial sources in the study area

Source	SPM		SO$_2$		NO$_x$		Activity	Discharge (t)		
	Generation co-eff	Discharge co-eff	Generation co-eff	Discharge co-eff	Generation co-eff	Discharge co-eff		SPM	SO$_2$	NO$_x$
Domestic and commercial sectors	0 34 kg/person	0.34 kg/person	Nil	Nil	0 019 kg/person	0 019 kg/person	2 5x10^6	850	Nil	48

4.3 Water pollution

4.3.1 Generation and discharge of pollutants

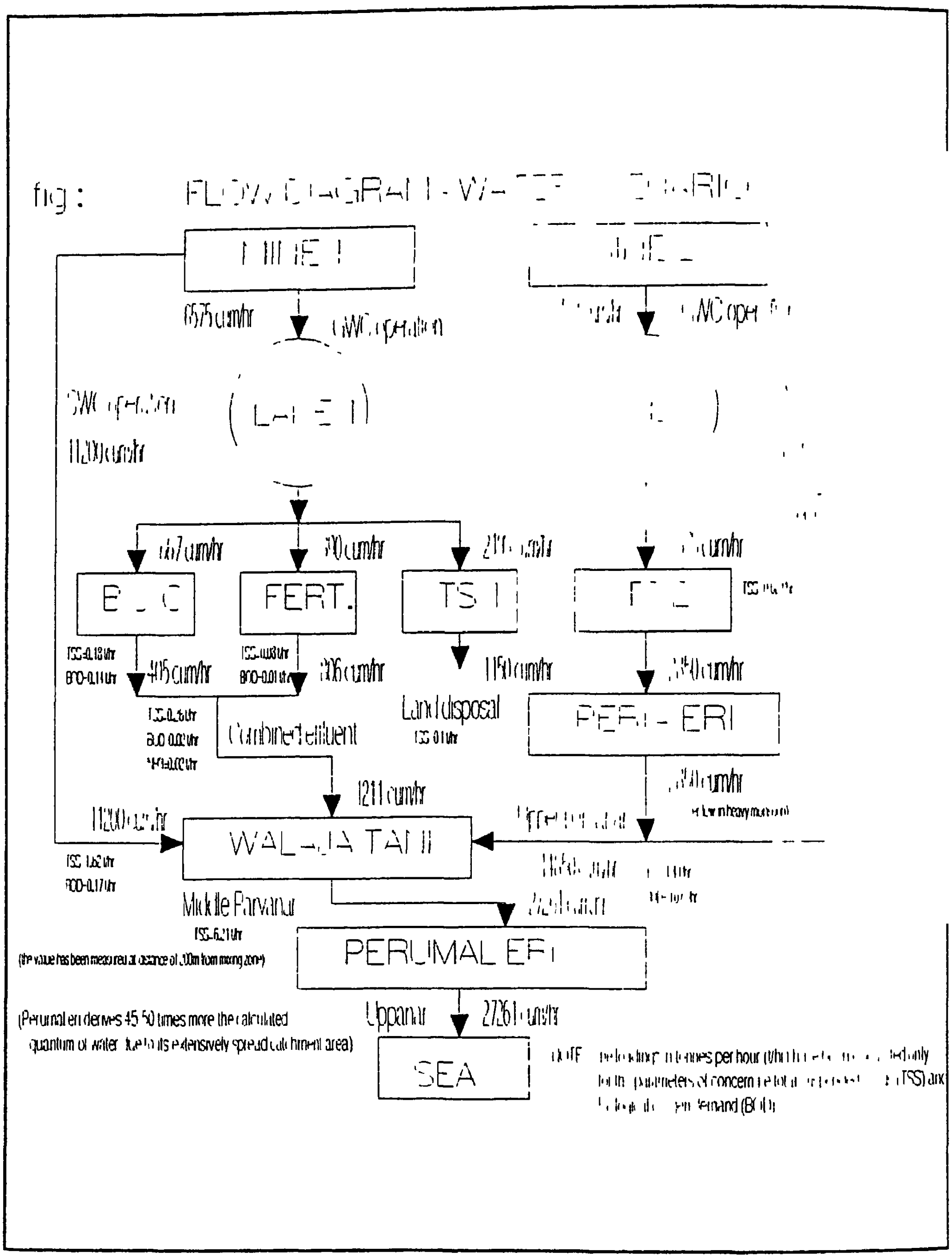
Generation and discharge of major pollutants (TSS & BOD) have been estimated for the thermal power stations (TS-1 and TS-2), fertiliser plant and B&C plant. Information from other industries in the area was not available. Figure 4.1 gives the flow quantum and loadings carried by the effluent streams arising due to the ongoing activities of NLC.

Table 4.6 gives the details of generation and discharge of main pollutants.

Table 4.6. Discharge factors, activity levels & present discharges of TSS, BOD

Industry	Discharge factors (effluents)	Activity (1993-94)	Discharge of BOD (t)	Discharge of TSS (t)	Receiving body
Power	**TSS BOD**				
TS-1	0.41 0 03 t/MKWh	2372 MKWh	80 59	973 2	Land irrigation
TS-2	0 031 0 02 t/MKWh	7024 5 MKWh	124.83	220.8	Peria eri
Industry					
Fertiliser	1989 19 636 t/Mt,urea	0 111 Mt urea	70 6	220.8	Walaja tank
B & C	6946 25 5402 6 t/Mt coke	0 227 Mt coke	1226 4	1576.8	Walaja tank
Mining (opencast)					
Mine I	23180.3 134 8 t/Mt lign	6.5 Mt lignite	876 4	150672	Walaja tank
Mine II	2362 25 68 9 t/Mt lign	8 9 Mt lignite	613 2	21024	Walaja tank
Grand Total			2992 02	174687 6	

Figure 4.1. Flow diagram - water scenario and loading



4.3.2 Existing water pollution control measures

The existing control measures in these plants are given in Table 4.7.

Table 4.7. Existing control measures for effluent streams from industries

Industry	Treatment	Type of treatment	Remarks	Impact
Mines				
Mine I, storm water	no treatment	no treatment	TSS is very high	results in silting of tanks and drains
Mine II, storm water	no treatment	no treatment	TSS is high	—do—
Power plants				
TS-1	Ash pond (HAD) a)area 10 Ha	Primary treatment	meets standards	insignificant
TS-2	Ash pond (HAD) a)area 30 Ha (for stage 1) b)area 40 058 Ha (for stage 2) c)capacity 0.24 MCM (st 2)	Primary treatment	meets standards	insignificant
Industry				
Fertiliser	no secondary level treatment	Primary treatment, settling pits	650 cu m/hr of raw water is wasted in diluting conc ammonia vapours from Barometric condenser unit, Ammoniacal nitrogen - high	significant
B & C	no treatment for the common effluent. The treatment exists for the phenols for the stream from the By-products recovery plant	no treatment for common effluent Secondary treatment for phenols	TSS, BOD found to be very high after secondary treatment.	significant

4.3.3 Water Balance

The water balance discusses quantitatively the usage pattern of water by various industrial units which act as major consumers of water. Refer to the principle flow sheet (Figure 4.1), depicting that the ground water control pumpage from Mine I is led to the lake I from where water is utilized by industrial units namely TS-I, Fertilizer and B&C plant. From Mine II the ground water control pumpage is led to lake 2 from where the water is used up by TS-2. The storm water pumpage from both the mines is led out into the villages via series of interactive tank systems.

Details of industrial water balance are presented in Annexure 4.1.

4.3 Land reclamation

NLC has launched a massive afforestation and reclamation programme in the area since the early 1980's. A total of 2653 Ha of land has been afforested till January 1994, which includes dumps, areas surrounding the mines, TPS and lignite stock yard and townships. A total of 156 lakh trees have been planted between 1982 and 1993. These afforestation activities has transformed the dull and dreary landscape caused by mining into lush green woods.

NLC's objectives of land reclamation are:

- 10-20% (high dump area) to be converted into hill top forest
- 17-20% of the land to be converted into water body for fish culture, irrigation, etc.
- 65-70% to be reclaimed for productive cultivation which includes afforestation, pasture land and agriculture.

The operational aspects of the reclamation plan are as follows:

- Planned overburden placement including back fill and regrading of the mined out area to a gentle topography consistent with other adjacent unmined area.
- Establishment of drainage network to minimise erosion.
- Use of biological reclamation techniques on the dumped soil (application of bio-fertilisers, humic acid, organic matter and cultivation of leguminous crops, etc).

- Careful selection of plant species and planting methods.
- Planting of leguminous and other nitrogen fixing plants.
- Arrangement of irrigation system and post care.

4.4.1 Reclamation of external dump

The excavated overburden when dumped externally over a large area with a dumping height of 60 m, creates major problem of erosion and silting of water bodies, especially during heavy rains. The normal slope of the dump face will be the angle of repose of the soil and for Neyveli soil the angle of repose is 38°. The overall slope of the dump soil is 1 3 and reclamation activities on this slope is difficult.

NLC has tried many methods of reclamation/ revegetation of the dump slopes over the past 10 years. These methods include pit method, hydroseeding, biscuit method and gunny bag planting. All these methods did not prove to be successful. Finally they decided to reduce the gradient of the dump slope to 1: 20 through dozing for reclamation purposes. The next step is prepare the soil in the slope by ploughing or digging for growth of vegetation. Since the dumped soil is poor in nutrients NPK and humus, ingredients were added. The soil is pretreated (for each acre) with 2 t of saw dust; 100 m^3 of farm yard manure or press mud or compost; 1 t of fly ash and 10 t of lignite dust for improving the fertility of the soil. Attempts were made for growing grass and this method has shown good results success rate of grass cultivation was almost 100%. Grass species planted are Brachiaria mutica, Cynodon dactylon, Panicum maximum, echinocholana - sp etc. Growing of grass on slopes has aided in stability of the slopes and the grass land is left as a pasture land for animals.

4.4.2 Reclamation of back filled (inside dump) area

a. NLC has carried out extensive afforestation work in Mine I inside dump area. Methodology adopted is as follows:

Bull-dozers are engaged for rough levelling of the area just sufficient to undertake planting work. Then the area is divided into small plots depending upon the nature of ground and each plot is numbered. A network of roads are made by bull-dozers to have transportation facility to those plots in order to take up afforestation programme. After the

7

formation of plots, contour trenches of 30 cm width and depth are formed at an interval of 1.5 m. The soil excavated from the trenches are put at the down side of the trenches in a semi-circular form which helps more storage of water in trenches. In these trenches small pits of 30 cm deep are cut at 1.5 m interval in order to plant the saplings. The saplings prepared in nursery are transplanted in these pits prepared in the contour trenches. These plant are tied with sticks till they establish their roots and able to stand themselves against wind.

Planting is normally done in the months of October, November and December which are the rainy months. During dry periods watering is done manually. The plants are watered twice a week. The rain water collected in low lying areas and pits is used for this purpose. When these go dry the water is supplied through trucks. Wherever feasible pipelines are laid out for irrigation.

b. Conversion of dumped area into agricultural land

NLC has carried out experiments in converting a small area of 10 acres of the dumped area into agricultural land. The area chosen was originally planted with tree (3-5 years life) and these were cut and this land was used for agriculture. Methodology adopted is as follows:

- extensive ripping and ploughing of the area by tractor implements.
- soil tests were carried out in the area and based on the results, ingredients were added like saw dust - 10 t, lignite dust - 4 t, gypsum 1.2 t, urea 24 kg, potash - 27 kg, super 27 kg, farm yard manure 40 m^3. At the first instance, 40% quantity of the ingredients required is added, the area is watered and ploughed by tractors.
- next green manure crop like sunhemp, dauicha, calapagonium, etc. were sown. Within a period of 4 months, the plants grew in size fixing root modules.
- the entire area was once again ploughed after materity of the crop.
- The whole procedure of green manure crop was repeated for 2nd season after adding 40% quantity of the selected ingredients.
- Balance 20% of ingredients were added in 3rd season and the entire operation of ploughing, sowing (green manure crops) etc was repeated.
- After every season, the soil quality and yield were recorded.

By this process, there was significant enrichment of the dump soil and it was found to be suitable for agriculture.

The advantages of slope vegetation are stability of slope, control of soil erosion, water absorption, improved soil condition and retaining run-off water. The conversion of slope into pasture land has improved the landscape and gives a pleasant look. The top of the external dump is also prepared, levelled and graded to the final topography with provisions to form small ponds, so that the water collected in these ponds during rainy season can be utilised for watering the plants and trees planted on the top surface.

4.4.3 Plantation programmes

The details of area covered by plantation are given in Table 4.8.

Table 4.8. Statement showing the area covered for plantation work upto January 1994 (unit-wise and area-wise) - area in Ha

Year	Mine I	Mine II	TPS II	Lignite dump yard	Township	Total
Upto 1982	26	-	-	-	-	26
1982-83	76	60	31	57	66	291
1983-84	93	33	24	31	66	247
1984-85	45	56	3	69	2	175
1985-86	161	84	2	-	121	368
1986-87	140	100	10	27	145	422
1987-88	108	106	10	24	194	442
1988-89	78	1	-	36	70	184
1989-90	18	14	-	8	83	121
1990-91	45	-	-	4	13 Cashew 80	142
1991-92	-	-	-	-	60 Cashew 65	125
1992-93	10	7	-	-	8 Cashew 31	56
1993-94	-	6	-	-	18 Cashew 30	55
Total	800	467	80	258	1050	2655

In Mine I, 216 Ha of back-filled dump area has been reclaimed through plantations. the external dump top and slope are also afforested, but due to expansion of Mine I (from 6.5 Mt to 10.5 Mt), these dumps are being raised through fresh dumping. An area of about 10 Ha in the internal dump (back-filled) is being experimented for agriculture crops. In Mine II reclamation work has not yet started.

Species details

NLC has experimented with as many as 38 species over the last 11 years. A summary of the major species planted in different areas is given in Table 4.9.

Table 4.9. Planting of trees from the inception upto January 1994 (Figures in lakhs)

No	Species planted	Mine I	Mine II	TPS II	Dump yard	NTS	Total
1	Eucalyptus sp	19.77	15.45	4 41	3.84	22.69	66 16
2	Acacia auriculiformis	7 9	0.88	1 34	2.11	8 96	21 19
3	Leucaena Leucocephala	6.66	0.32	0 42	0 75	4 64	12 81
4	Casuarina equisetifolia	3 2	2.84	0 88	1 97	5 56	14 5
5	Bamboo	1.7	1.25	-	0.4	2.65	6
6	Agave mexicana sp	5 75	4.19	-	1.47	-	11.41
7	Cashew	-	-	-	-	0 29	0.29
8	Fruit trees	0.26	0.01	0 01	0.19	0.33	0 8
9	Avenue trees	0.16	0.15	0.01	0.05	1 58	1.95
10	Timber trees	5.19	0.96	0 01	0 95	0.95	8.06
11	Miscellaneous	2.59	4.2	0.14	1 21	5.16	13.3
	Total	53 18	30.27	7.22	12.94	52.81	156 47

The types of species planted under the category fruit trees, avenue trees, timber trees and miscellaneous are detailed in Table 4.10

Table 4.10. Different types of species planted by NLC

Fruit trees	Timber trees	Avenue trees	Misc trees
Mango Guava Sapota	Terminalia alata Melia dubia Parkinsonia aculeata Acacia nilotica Acacia Leucophloea Tectona grandio (Teak) Azadirachata indidica (Neem) Albizzia lebbeck Dalbergia sissoo Pithecellobium dulce Madhuca latifolia	Copper Delonix regia (Gulmohar) Samanera saman (Ravi tree) Mimosops eleugi (Maulshri) Parkia biglandulosa Bauhinia spp Tabebuia pentaphylla (Tabebuia rosca) Pride of India	Silk cotton Ficus glomerata Tamarindus indica (Tamarind) Cocosmicifera (Coconut) Cassia fistula Other minor trees

The details of the varieties of species planted in the damaged mining areas are as follows:

Table 4.11. Types of species planted on dumping yard and slopes in NLC

Dumped area	Slopes
Terminalia arjuna* Melia dubia* Toona ciliata* Grevillea robusta* Parkinsonia aculeata* Acacia catechu Acacia planifrons* Subabul (Hawaian giant*) Anacardium occideutale (Cashew)* Eucalyptus hybrid Casuarina equisetifolia Dendrocalamus strictus Leucaena leucocephala Acacia auriculiformis Avenue trees Azadirachta indica (Neem) Albizzia lebbeck Samania saman Dalbergia sissoo* Ceiba pentandra*	Accacia auriculiformis Prosopis juliflora Agave mexicana* Pithecellobium dulce Neem Athi (Ficus glomerata) Murraya koenigii* Bassia latifolia

* These tree species would not be planted in dumped areas.

4.5 Translating emissions to ambient air quality concentration profiles using natural systems models

4.5.1 Air quality model

Air quality is the reflection of the concentration of pollutants over a period of time. It depends upon various factors such as discharge characteristics (height, temperature, exit velocity, etc.) and prevailing wind speeds and directions, and atmospheric stabilities. For localised impacts, it is the concentration of pollutants that people are exposed to which are of concern, and therefore, it is important to be able to translate emission loads to air quality concentration profiles.

There are numerous models available that can be used to simulate the air quality. However, the choice narrows down drastically, based upon the intensity and type of data required on emission as well as meteorological. Generally, a judicious balance between the accuracy requirements and input data availability guides the selection of the model. Once selected, emission data (all significant sources along with discharge detail) and meteorological inputs need to be specified. Generally there is a fair level of uncertainty in specifying emission and meteorological data coupled with the capability (goodness) of the algorithm itself in simulating real-life dispersion there will always be a need to calibrate the model by comparing model results with actual monitored data. Once calibrated, the model can be used for predicting air quality levels in the study area due to future growth of activities, use of control measures, etc. For this study we have used the PAL (Point Area Line) source model developed by USEPA.

PAL is a multi-source Guassian plume atmospheric dispersion algorithm for estimating concentrations of non-reactive pollutants. Concentration estimates are based on hourly meteorology, and averages can be computed for averaging time from 1 to 24 hours. Six source types are included in PAL: point, area, two types of line sources and two types of curved path sources. At the heart of PAL is the Guassian plume point source equation. The equation is used directly in the computations for point, line, and curved path sources, and in a modified form for area sources. A unique feature of PAL is the computational technique for estimating the concentration from area sources. This technique incorporates edge effects and is theoretically more accurate than the

Chapter 5. Future scenario of economic activities (upto 2020)

The economic activities which will grow in the future are lignite mining and additional power generation from existing as well as new power stations. Other industrial activities in the area are also likely to increase in the future due to increased power availability. Because of increase in population, transportation and constructional activities would also increase in the future.

5.1 Master plan activities

Lignite mining and power generation are the two activities which are identified for growth in the master plan. No downstream industries based on lignite have been planned for the future. The existing fertiliser and B&C plants would continue to operate.

5.1.1 Mining

Neyveli sub-area
Mine I expansion, Mine II expansion and Block B are likely to be taken up in the future period upto 2020. The lignite production from the existing mines including expansion plans and Block B are given in Table 5.1.

Jayamkondam sub-area
The lignite mine in Jayamkondam is projected to start production from 2000. The details of production are given in Table 5.1.

Bahour sub-area
As per the master plan the lignite mining starts only in 2051.

The details of lignite production from Neyveli and Jayamkondam up to 2020 are given in Table 5.1.

Table 5.1. Lignite production estimates upto 2020 .

Mine	Reserves (Mt)	O/L ratio (m^3/t)	Production projections (Mt)			
			1996	2001	2011	2020
I	257	5 0 1	6 5	9 5	10 5	8 0
II	503	4 6 1	9 0	10 5	13 5	13 5
Block B	400	7 1·1	-	-	-	9 0
Neyveli sub-area	1160		15 5	20 0	24 0	30 5
Jayamkondam	611	7 8 1	-	6 0	9 0	9 0
Total	1771		15 5	26 0	33 0	39 5

Note: Block 'B' starts production in 2013 and Jayamkondam mine starts production in 2000.

5.1.2 Power generation

New power plants with a total generating capacity of 4670 MW are proposed to be installed by the year 2020 The details of these plants are given in table 5.2

Table 5.2. Details of proposed power plants under the master plan

Power plant	Units and capacity
TS-1 expansion	2 x 210 = 420 MW
STCMS TPS	3 x 250 = 750 MW
TPS A/B	4 x 500 = 2000 MW
Jayamkondam TPS	3 x 500 = 1500 MW
Total	= 4670 MW

As per the master plan projections, existing TS-1 will be closed down in 2013. The power generation upto 2020 is given in Table 5.3.

Table 5.3. Power generation estimates upto 2020

TPS	Capacity (MW)	PLF (%)	sp lignite consumption (Kg/KWh)	Power generation (MKWh)			
				1996	2001	2011	2020
Existing							
TS-1	600	72 0	1 422	3784.32	3784.32	3784.32	closed
TS-2	1470	63 0	1 145	8112 63	8112 63	8112 63	8112 63
Future							
TS-1 Exp.	420	76 5	1 063	—	—	2814 6	2814 6
STCMS	750	76 5	1 17	—	1675.35	5026 06	5026 06
TS-AB	2000	76 5	1 03	—	—	—	13402 8
Neyveli sub-area				11896 95	13572.3	19737 61	29356 09
JK sub-area	1500	76 5	1 03	—	3350 7	10052 1	10052 1
Grand total				11896 95	16923 0	29789 71	39408 19

Note :

i) TS-1 will close down in 2013

ii) TS-1 expansion units will be in operation in 2003

iii) STCMS units : 1st unit in operation in 1998, 2nd and 3rd units in 2003

iv) TS-A/B units : 1st unit in 2012, 2nd & 3rd units in 2013, 4th unit in 2016

v) Jayamkondam TS-JK : 1st unit in 2000, 2nd unit in 2001, and 3rd unit in 2005

vi) The PLF of all future units is taken as 76.5%

5.2 Population

The population projections for the study area in the year 2001 and 2020 is estimated at 2.75 million and 3.72 million respectively. This is based on an annual growth rate of 1.6 % (which is the projected growth rate of Tamil Nadu). The share of urban population is assumed at 38.7 %.

5.3 Other economic activities

5.3.1 Industries

The projections for other economic activities in the area have not been possible due to lack of data on existing levels of industrial activity. In Neyveli sub-area, the MRK sugar unit would continue to be in operation. In Jayamkondam area, it is difficult to project emergence of industrial activity due to the proposed mining and power plant.

5.3.2 Transport

Transport activities are expected to grow in all the three sub-areas due to increase in population with subsequent increase in lignite production and power generation. It has not been possible to estimate the projected growth in transport activities due to lack of data.

5.3.3 Domestic sector

Because of increase in population, the consumption of different types of fuel for domestic use would increase.

5.4 Prospects of master plan projects beyond 2020

Additional lignite mining and power generation activities have been projected for the period beyond 2020. The details are given in Table 5.4.

Table 5.4. Projected lignite mining and power generation activities beyond 2020

Activity		Capacity (Mt/a)	Life (Years)	Starting year
A. MINING				
Neyveli sub-area				
- Mine III		13.5	44	2030
- Mine-South of Vellar		9	45	2039
- Block A		6	18	2022
Jayamkondam sub-area		9	68	2000
Bahour sub-area		10.5	43	2051
B. Power generation (MW)				
Neyveli sub-area				
TPS-2 (Existing)		1470	-	Life upto 2032
TPS-1 Expansion		420	39	2000
Zero unit:	1 unit	250	45	1998
	2 units	500	36	2003
TPS III:	3 units	1500	43	2030
TPS B:	4 units	2000	40	2013
TPS S Vellar:	3 units	1500	45	2039
TPS JK:	3 units	1500	35	2000
TPS Bahour		1500	45	2051

Chapter 6. Environmental impact assessment - future scenario

6.1 Most important impacts of the master plan projects

Because of the projected increase in lignite production, power generation and related economic activities in the area, the generation of waste loads and land degradation would increase in the future. The most important impacts of the master plan projects are identified as land occupation, ground water pumpage, water drainage, displacement of population due to acquisition of land. The other impacts are on noise levels, air quality, water quality, eco-systems and landscape. This trend of continued increase in pollution would require that control measures are undertaken to ensure that environmental standards are met. In this chapter, an assessment has been made of the various impacts due to the master plan projects and in the subsequent chapter, the control measures are discussed.

6.1.1 Impact on land environment due to mining operations

It is estimated that about 5581.7 Ha of land would be affected by mining operations till 2020 in Neyveli area and 2308 Ha in Jayamkondam area. The mine-wise, year-wise requirements of the different types of land are given in Annexure 6.1.

6.1.1.1 Land occupation due to mining (upto 2020)

The mine-wise land requirement upto 2020 has been estimated (by M/S LAUBAG) and is given in Table 6.1.

Table 6.1 Mine-wise land requirement upto 2020

Mine	Year	Total	Land requirement (Ha)				
			Agriculture	Forest	Waste land	Water body	Other
Mine I	Till 1994	1410.8					
	1995-2020	2108.6	1810.9	0.0	152.3	0.0	145.4
	Total	3519.4					
Block A	2018-2020	100.2	100.2	0.0	0.0	0.0	0.0
Mine II	Till 1994	1117.4					
	1995-2020	2414.9	1982.3	0.0	251.4	0.0	181.2
	Total	3532.3					
Block B	2009-2020	958.0	873.1	0.0	84.9	0.0	0.0
Neyveli sub-area	Till 1994	2528.2					
	1995-2020	5581.7	4766.5	0.0	488.6	0.0	326.6
Jayamkondam sub-area	1998-2020	2308.1	2281.4	0.0	26.7	0.0	0.0

6.1.1.2 Land occupation due to other activities

Details of estimated land requirement till 2020 for other activities are given in Table 6.2.

Table 6.2. Land requirement due to other activities

Activity	Neyveli sub-area (Ha)				JK sub-area
	Mine I	Mine II	Block B	Total	
1. For conveyors and transfer houses	6.99	32.53	32.77	72.29	-
2. Lignite storage	25.06	2.17	-	27.23	-
3. Workshop and mine offices	169.16	95.18	95.18	359.52	95.18
4. Roads along the conveyors	106.02	-	-	106.02	-

6.1.1.3 Land occupation due to mining beyond 2020

The details of land occupation due to mining activities beyond 2020 are given in Annexure 6.2.

6.1.2 Impact on ground water quantity

The ground water situation till 2020 is characterised by an increasing deficit. Including the possible river bank infilteration from Coleroon river the annual ground water recharge will slightly increase. On the other hand the mines pumpage will increase, too. It is assumed that irrigation pumpage will increase by about 10 % within the next 25 years. Pumpage for water supply of Neyveli town and the surrounding industries should be on the same level as in 1994. Table 6.3 gives the industrial requirements of water for the master plan projects till 2020, based on the assumption of 60 % ash water recovery.

Table 6.3. Future industrial requirement of water: 60 % ash water recovery

Year	TS's (Neyveli) existing & proposed mcm/yr	ST-CMS (private und.) mcm/yr	TS JK mcm/yr	Cumulative TS's requirement mcm/yr
1995	88.01			88.01
1996	88.01			88.01
1997	88.01			88.01
1998	88.01	7.7		95.71
1999	88.01	7.7		95.71
2000	88.01	7.7	14.99	110.70
2001	88.01	7.7	29.98	125.69
2002	88.01	7.7	29.98	125.69
2003	97.31	23.1	29.98	150.39
2004	97.31	23.1	29.98	150.39
2005	97.31	23.1	44.97	165.38
2006	97.31	23.1	44.97	165.38
2007	97.31	23.1	44.97	165.38
2008	97.31	23.1	44.97	165.38
2009	97.31	23.1	44.97	165.38
2010	97.31	23.1	44.97	165.38
2011	97.31	23.1	44.97	165.38
2012	112.30	23.1	44.97	180.37
2013	120.88	23.1	44.97	188.95
2014	120.88	23.1	44.97	188.95
2015	120.88	23.1	44.97	188.95
2016	135.87	23.1	44.97	203.94
2017	135.87	23.1	44.97	203.94
2018	135.87	23.1	44.97	203.94
2019	135.87	23.1	44.97	203.94
2020	135.87	23.1	44.97	203.94

With the calculated mine pumpage (prediction run 2) the total balance will be more negative till 2020. Probably the negative ground water balance will increase from 174 mcm/a in 1995 to 268 mcm/a in 2020. Refer to Table 6.4 and Figure 6.1.

Table 6.4. Ground water balance 1995 to 2020

Year	Total pumpage (mcm/a)	Recharge (mcm/a)	Balance (mcm/a)
1995	349	175	-174
1996	349	177	-172
1997	344	179	-165
1998	379	181	-198
1999	390	181	-209
2000	408	183	-225
2001	468	188	-280
2002	445	190	-255
2003	451	193	-258
2004	449	195	-254
2005	422	195	-227
2006	451	198	-253
2007	439	200	-239
2008	457	202	-255
2009	447	204	-243
2010	441	205	-236
2011	445	207	-238
2012	446	208	-238
2013	468	211	-257
2014	460	212	-248
2015	456	213	-243
2016	444	215	-229
2017	459	216	-243
2018	507	218	-289
2019	499	220	-279
2020	489	221	-268

This means that the sinking tendency of the ground water level will continue. For instance, Figure 6.2 shows the calculated ground water levels of Kurinjipadi observation well.

Figure 6.1. Ground water balance till 2020

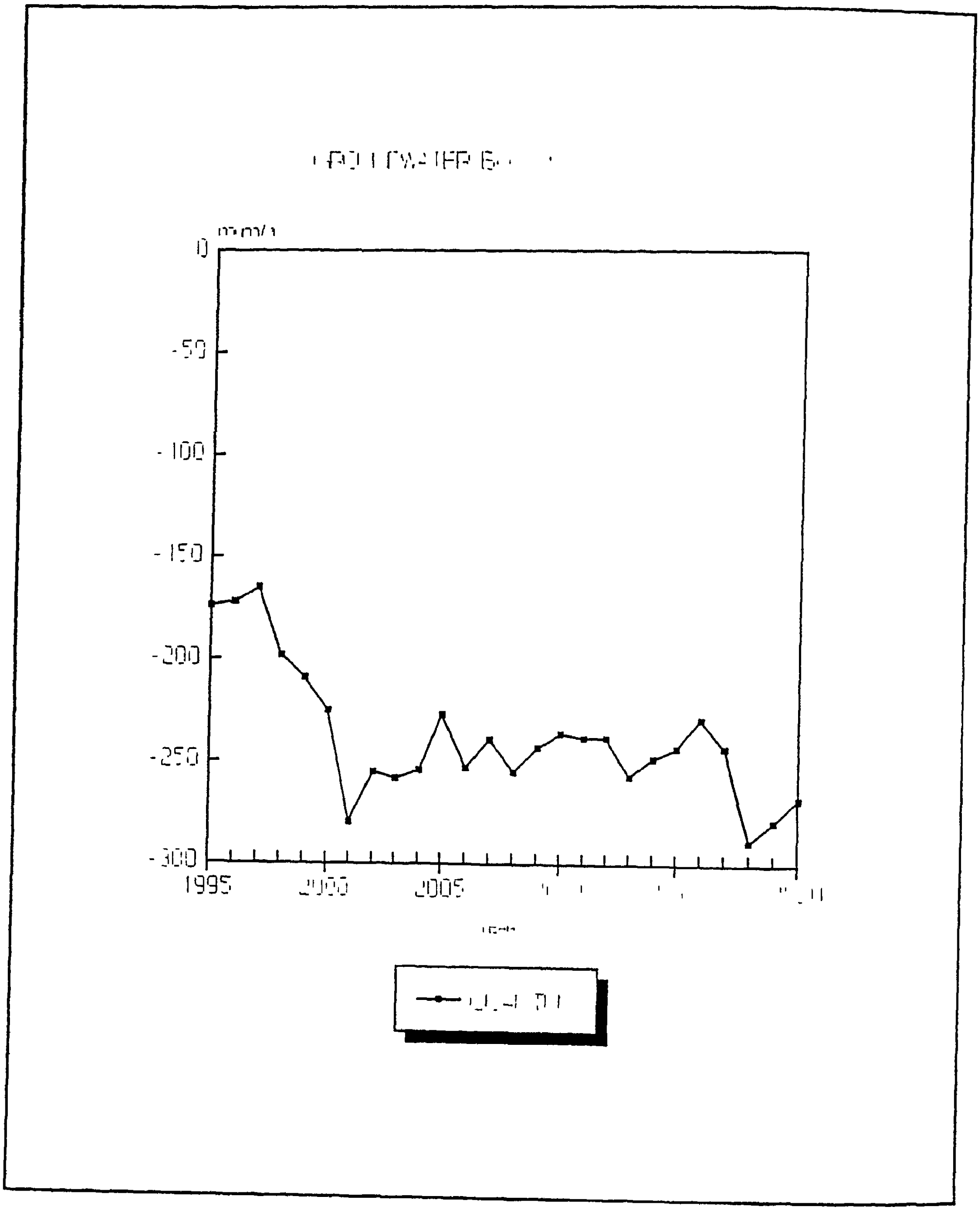


Figure 6.2. Kurinjipadi observation well levels till 2020

Note: Please print LAUBAG's GRAPH (From LAUBAG)

6.1.3 Impact on socio-economics (Rehabilitation)

Population likely to be displaced/affected by mining activities
For Mine I and Mine II expansion schemes, NLC Ltd has tentatively assessed the population likely to be affected/ displaced. The details are given in Table 6.5 For Block B, an area of 958 Ha is required till 2020 The villages likely to be affected are Seppalanattam, Karunguli, Kulakkudi, Nayinakuppam, Maruvay and Kaduvetti. To arrive at an estimated figure of population likely to be affected in Block B project, the ratio of total families affected per Ha of land for Mine II has been used. This is a rough estimate and to obtain a reasonable estimate, a proper survey has to be done in association with NLC.

Table 6.5. Population likely to be affected by mining activities

Project	Land reqd, Ha	No of families likely to be			Total families affected/ Ha
		displaced	affected	Total	
Mine I exp 6.5-10.5	780	410	1500	1910	2.45
Mine II exp	1294	465	3200	3665	2.83
Block B	958	NA	NA	2424	2.83

NA - Not available

6.1.4 Impact on noise environment

The industrial activities in Mine I & Mine II, TS-1 & TS-2, Fertiliser, briquetting plant and vehicular traffic on road were identified as major contributor in existing noise level scenario of Neyveli region. The ambient noise level was measured at 20 sampling stations to observe the existing noise level scenario in Neyveli. The noise level in Neyveli township was observed to be varying from 54 to 57 dB as shown in figure 3.30, whereas, noise level of 56 to 62 dB was found in the surroundings of power plants and mines (figure 3.30).

Sound propagation from a source to receiver depends upon the properties of the atmosphere in the presence of any object or barrier in the transmission path. The sound pressure level generated by a noise source decreases with increasing distances mainly due to wave divergence There is an additional decrease called excess attenuation in sound pressure level with distance from the source due to atmospheric effect or interference with objects in the transmission path. The cumulative noise level at particular location, due to noise sources within the stipulated area, can be computed by using following model for hemispherical sound wave propagation through homogeneous medium.

$$Lp_2 \quad = \quad Lp_1 - 20 \log (r_2/r_1) - A\ e_{1\,2}$$

where Lp_2 and Lp_1 are the noise levels at the distance r_2 and r_1 from the source, and $A\ e_{1,2}$ is the excess attenuation due to environmental absorption, scattering, etc.

Also, total noise pressure level Lp (total) due to all the sources can be determined by summing them as;

$$Lp\ (total) = 10 \log (10^{Lpa/10} + 10^{Lpb/10} + 10^{Lpc/10} + \ldots\ldots..)$$

where Lpa, Lpb and Lpc are the noise pressure levels at the sampling point due to sources a,b,c, etc.

All the proposed industrial activities namely power plants and mines were taken into account to obtain the predicted noise level for Neyveli region. The ambient noise level monitored at 4 directions in TS-2 and Mine II were considered for proposed thermal stations and mines for the prediction of noise at different distances from the sources. The predicted noise level for Neyveli region was obtained by using the hemispherical sound wave propagation model and the results are presented in figure 6.3 to 6.5. The figure shows the increase of noise level by 1 dB in Block-27, Block-28 and Block-28 of Neyveli township due to the expansion of TS-1 (2x210 MW). The noise level in rest of the blocks in the township will remain unchanged due to the proposed expansion activities. Background noise level measured in Erumbur and South of Vellar which are currently agricultural areas was found to be 53 and 52 dB respectively. The noise level in these areas could increase by the order of 5 to 8 dB due to outcome of Mine III, TS-3 and South of Vellar mines.

Figure 6.3. Predicted noise level for Neyveli region till 2003

Figure 6.4. Predicted noise level for Neyveli region till 2013

Figure 6.5. Predicted noise level for Neyveli region till 2030

Existing noise level in Jayamkondam area is of the order of 48-56 dB. Vehicular traffic has been identified as the main source of noise in Jayamkondam town. The noise level scenario in Jayamkondam town has been predicted to remain unchanged due to proposed power plants and mining. Noise level will be increased by the order of 6-8 dB in the surroundings of power plant and mines in Jayamkondam area.

Existing noise level in Bahour area was observed to be well below than the prescribed standard of CPCB for residential area. Noise level will be increased by the order of 6-8 dB in the surroundings of power plant and mines in Bahour region.

6.2 Environmental quality assessment

6.2.1 Air quality

Generation and discharge of pollutants
With the plans for expansion of mining and power generation in the study area, the generation and discharge of pollutants would increase in the future. The projection of future emission loads are based on the estimated activity levels in 2020 and provision of ESP's in power plants and are given in Table 6.6.

Predicting ambient air quality levels
The PAL model has been used to predict the concentrations from TS-I expansion units (2x210 MW) and from STCMS (3x250 MW). The model has been initially run for the winter season for 30 days. Results are shown in Tables 6.7 and 6.8. As seen the average concentrations for the winter season are extremely small. The maximum daily concentrations just about reach double figures.

Table 6.6. Generation and discharge of air pollutants in Neyveli and Jayamkondam areas

Source	SPM		SO_2		NO_x		Activity	Discharge (t)		
	Generation co-eff	Discharge co-eff	Generation co-eff	Discharge co-eff	Generation co-eff	Discharge co-eff		SPM	SO_2	NO_x
Power										
TS-1 *	84 6 g/kWh	8 5 g/kWh	19 9 g/kWh	19 9 g/kWh	9 95 g/kWh	9 95 g/kWh	3784 MkWh	32015	75307	37652
TS-2	68 1 g/kWh	6 8 g/kWh	16 g/kWh	16 g/kWh	8 02 g/kWh	8 02 g/kWh	8113 MkWh	55165	129802	65063
TS-1 Exp	63 3 g/kWh	6 3 g/kWh	14 9 g/kWh	14 9 g/kWh	7 45 g/kWh	7 45 g/kWh	2815 MkWh	17814	41937	20979
STCMS	69 4 g/kWh	6 9 g/kWh	16 3 g/kWh	16 3 g/kWh	8 17 g/kWh	8 17 g/kWh	5026 MkWh	34881	82076	41063
TS-A/B	61 3 g/kWh	6 1 g/kWh	14 4 g/kWh	14 4 g/kWh	7 21 g/kWh	7 21 g/kWh	13403 MkWh	82139	193268	96634
TPS-JK	61 3 g/kWh	6 1 g/kWh	14 4 g/kWh	14 4 g/kWh	7 21 g/kWh	7 21 g/kWh	10052 MkWh	61317	144749	72374
Industries										
Process steam plant	14 78 kg/t of steam	1 5 kg/t of steam	3 475 kg/t of steam	3 475 kg/t of steam	2 192 kg/t of steam	2 192 kg/t of steam	1 766 Mt of steam	2649	6137	3871
Fertiliser	10 kg/t of urea	10 kg/t of urea	0 7 kg/t of urea	0 7 kg/t of urea	2 kg/t of urea	2 kg/t of urea	0 111Mt of urea	1110	78	222
B&C	NA	NA	NA	NA	NA	NA	0 227 Mt of coke	NA	NA	NA
MRK Sugar	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chemplast	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

* TS-1 will be functioning till 2013 only.

Table 6.7. Predicted SO_2 Concentrations ($\mu g/m^3$) due to TS1 expansion (2*210 MW)

Receptor	Simulated Day # (Winter Season)																														Seasonal average, Daily max.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Neyveli Bl-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Kurinjipadi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Kullanchavadi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Sethiatope	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Srimushnam	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
TVPuttur	1	0	2	0	0	1	2	2	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0, 2
Sathamangalam	1	0	3	0	0	0	3	3	2	1	0	0	0	0	2	1	2	3	2	0	0	1	0	0	2	1	2	1	0	2	1, 3
Nadukuppam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Kadampuliyur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
C Mutlur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Bhuvanagiri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Chozhatharam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Valaimadevi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Andimanam	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
Vridhachalam	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	1	3	2	2	0	0	3	0	0	2	2	1	2	0	1	1, 3
Mangalampet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0, 1
Jayamkondam	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
Gangaikondapuram	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
T Palur	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
Udayarpalayam	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
Irulankurichi	0	0	0	0	0	2	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0, 2
Cuddalore	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Tirupanampakkam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Mudaliarpettai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Valanur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0

Table 6.8. Predicted SO_2 Concentrations ($\mu g/m^3$) due to ST-CMS (3*250 MW)

Receptor	Simulated Day # (Winter Season)																														Seasonal average, Daily max
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Neyveli Bl-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Kurinjipadi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Kullanchavadi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Sethiatope	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Srimushnam	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
TV Puttur	2	0	0	0	0	1	6	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	- 0	0	0	0	0	0	1, 6
Sathamangalam	0	0	0	0	0	0	1	0	10	0	0	0	0	0	7	0	11	4	7	0	0	4	0	0	4	3	4	7	0	0	2, 11
Nadukuppam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Kadampuliyur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
C Mutlur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Bhuvanagiri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Chozhatharam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Valaimadevi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Andimanam	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
Vridhachalam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	6	0	0	0	0	0	0	0	0	0, 6
Mangalampet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Jayamkondam	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
Gangaikondapuram	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 1
T Palur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Udayarpalayam	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 2
Irulankurichi	0	0	0	0	0	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 3
Cuddalore	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Tirupanampakkam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Mudaliarpettai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0
Valanur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0, 0

6.2.2 Water quality

6.2.2.1 Effluent discharges and pollution loads

The present discharges are given in Table 6.9. With increased generation of power, water consumption will increase and the discharge of waste water from the new power plants would increase. The estimated discharges of BOD and TSS from the various activities in 2020 are given in Table 6.10. The projected discharges of future waste loads (TSS & BOD) in wastewater from the power plants and mines are based on the estimated activity levels and provision of control measures in the units.

Table 6.9. Effluent discharge factors, activity levels and present discharges of TSS and BOD

Industry	Discharge factors (effluents)	Activity (1993-94)	Discharge of BOD (t)	Discharge of TSS (t)	Receiving body
Power	**TSS BOD**				
TS-1	0.41 0.03 t/MKWh	2372 MKWh	80.59	973.2	Land irrigation
TS-2	0.031 0.02 t/MKWh	7024.5 MKWh	124.83	220.8	Peria eri
Industry					
Fertiliser	1989.19 636 t/Mt.urea	0.111 Mt urea	70.6	220.8	Walaja tank
B & C	6946.25 5402.6 t/Mt coke	0.227 Mt coke	1226.4	1576.8	Walaja tank
Mining (opencast)					
Mine I	23180.3 134.8 t/Mt lign	6.5 Mt lignite	876.4	150672	Walaja tank
Mine II	2362.25 68.9 t/Mt lign	8.9 Mt lignite	613.2	21024	Walaja tank
Grand Total			2992.02	174687.6	

Table **6.10.** Future effluent loadings from the thermal power plants (2020 AD)

Activity/parameter	TSS (gm/kWh)	BOD (gm/kWh)	Activity (MkWh)	Discharge of BOD (t)	Discharge of TSS (t)
TS-1 expansion	0.104	0.004	2814.6	11.25	292.7
TS-CMS	0.092	0.0038	5026.06	19.1	462.39
TS-A/B	0.089	0.0036	13402.8	48.25	1192.8
TS-JK	0.089	0.0036	10052.1	36.18	894.6
Total in 2020				3026.21	176556.9

6.2.2.2 Future effluent flow pattern and surface water quality

As discussed in chapter 2 the general topography of the land is east and south east, and therefore the effluents would flow towards the passages existing as of today and new passages in south east directions. The effluent generating sites i.e, thermal power station locations would show the following effluent drainage pattern, as below,

Table 6.11. Effluent flow patterns

Effluent discharge points/locations	
Existing units (from)	Location (To)
TS-1	Ash pond & overflow to land disposal for irrigation
TS-2	Peria eri
Fertiliser	Walaja tank via combined effluent drain
B & C	Walaja tank via combined effluent drain
Future units (Neyveli)	
TS-1 Expansion	Ash pond, excess to Walaja Tank
ST-CMS, Zero Unit	Peria eri, overflow to Walaja tank via Parvanar river
TS-A/B	Walaja tank, overflow to Perumal eri
Future units (Jayamkondam)	
TS-JK	Ponneri tank via Malangankudiyiruppu odai, and overflow to Coleroon river

TS-1 Expansion

The effluents arising as an overflow from the ash pond of the TS-1 expansion would be used for irrigational purposes in the same way as it is being used now. However in case of the excess overflow from the ash pond, the effluent channel would most likely join the combined effluent channel and later on Walaja tank.

The topography/slopes also reveal the same type of pattern.

Even for the existing TS-1, a new ash pond is soon to come up near the fertiliser unit, which again tells that the supernatant water from the new pond would join the combined effluent channel.

TS-A/B

TS-A/B is coming up in the north east of Mine II and adjacent to the eastern boundary of Block B mine. The topography of the area shows that the slope exists towards Walaja tank, hence, the effluents would enter into Walaja tank (2 to 3 km to the south of TS-A/B) via western side of Block B mine.

ST-CMS

ST-CMS or the Zero unit lies about 1.5 km from the thermal station 2. Peria eri lies 2-3 km to the south of this unit, hence the effluent comprising of overflow from the ash pond would enter Peria eri via the western garland canal of the Mine II along with TS-2 effluent. Since there is going to be an increase in the flow volume of the total effluent entering the eri, the excess water or the overflow would join Parvanar river. Parvanar river is at a distance of about 500 m to the east of Peria eri.

TS-JK

The water requirements of the thermal power station proposed to come up in Jayamkondam i.e, TS-JK are mainly going to be derived from the mine pumpages i.e ground water control operation. The thermal power station is proposed to come up in the north of the mine. There is no large source of water near the mines or thermal station as all the surface bodies are monsoon dependent. However, after the coming up of mine and thermal power station the area would develop induced perennial sources of water. Ponneri is the largest lake in the area near Puduchavadi extending 3.5 km in length and 1 km in width. This tank is situated on the eastern side of the eastern boundary of the proposed mine. To its south east lies Coleroon river at an aerial distance of 6.5 km.

Malangankudiyiruppu odai lies to the west of Ponneri and in the centre of the proposed mine area. The Ponneri would receive mine sump pumpage (storm water control operation) via this odai. This odai would need to be diverted along the northern/north-west periphery of the mine.

Surface water quality

Based on the effluent paths discussed above, for Neyveli region the changes in quality are expected to occur in Walaja tank. Since the effluents from thermal power station are negligibly polluting in nature the general quality of the surface water wont show a significant change Over and above, the mine pumpage would further dilute the effluents from industries/power stations.

But, the parameters which are most likely to be get significantly changed include TSS, TDS, and pH. Table 6.12 given the predicted values for effluents.

Table 6.12. Expected characteristics of effluents from thermal station ash pond effluent & mines

Parameter	Mine	Ash pond concentration	TNPCB
pH	7.5	8.3	5.5-9
TDS, mg/lt	375	850.0	2100
TSS, mg/lt	110	73.0	100
TS, mg/lt	485	923.0	-
Ammonical Nitrogen, mg/lt	0.60	-	50
Calcium as Ca, mg/lt	40	70.0	-
Magnesium as Mg, mg/lt	22	20.0	-
Total Alkalinity, mg/lt	100	100.0	-
Bicarbonate alkalinity, mg/lt	100	75.0	-
Carbonate alkalinity, mg/lt	0	25.0	-
Hydroxide alkalinity, mg/lt	0	-	-
Chlorides as Cl, mg/lt	60	102.0	1000
Sulphates as SO4,mg/lt	45	160.0	1000
Silica as SiO2,mg/lt	30	25.0	-
Sodium as Na,mg/lt	50	85.0	-
Pottassium as K,mg/lt	5	5.0	-
BOD, mg/lt	10	3.0	30
COD, mg/lt	100	16.0	250
Iron as Fe,mg/lt	0.01	0.15	-
Fluorides,mg/lt	0 8	0.4	2.0
Zinc,mg/lt	0.25	0.05	15
Phosphates,mg/lt	0.10	0.01	5
DO,mg/lt	5	6.0	-
Oil & Grease,mg/lt	1 1	1.5	10

The predicted surface water quality corresponding to the predicted effluent characteristics for the essential parameters are given below:

Table 6.13. Expected surface water quality

Name of the water body	Quality parameters									
	TSS, mg/l		TDS, mg/l		BOD, mg/l		DO, mg/l		pH	
	PRE	FUT	PRE	FUT	PRE	FUT	PRE	FUT	PRE	FUT
Walaja Tank	200	130-140	450	550-600	2	3-4	5 5	5-6	8	7 7-8
Coleroon River	10	60-75	150	458	2	3-4	7	6-6 5	7	7 5-8

PRE - Present value, FUT - Future value based on arithmetic averages

Ranges are based on future flows and expected concentration and are indicative of the expected future quality.

Note:

1) The above values have been calculated keeping in mind that only mine effluents and Thermal Station effluents would add in the future. No other downstream industry has been taken for predicting there quality determining values.

2) For calculating these values only data analysed by TERI for 4 seasons has been taken as baseline data, since no other/past data for same surface bodies was available.

The effluents from new power plants and mine water pumpage would carry increased load of TSS, and control measures like ash pond, sedimentation tank are being planned. Therefore, the general quality of the surface water would not show any significant change in its characteristics.

6.2.2.3 Groundwater quality

It is expected that the quality of the groundwater would remain the same as at present. However, the geophysical surveys should be carried out by conductivity measurements to establish the changes in the position of the sea-groundwater interface. To keep a check on the geophysical surveys, quality tests should be carried out regularly for the parameters like chlorides and bicarbonates.

6.2.3 Impact on eco-system and landscape

In the present scenario, there are no natural forests around proposed mines and mine expansion plans in Neyveli area. Therefore there is no treats as such for any native flora and fauna in this region at present. However, it is essential that the biomass in these areas are to be increased by large scale planting of trees on the mined out areas and in wastelands. NLC has taken up planting trees in the mine spoils and on the overburdens. The only care need to be taken is to incorporate the species which are native to this area such as thespesia populnea, Acacia nilotica, etc., which may help in harbouring the original fauna of the area.

One of the major danger of mining in Bahour may result in depletion of water levels in Osteri tank and reduction in bird diversity Further, due to large scale pumping of water into surrounding areas which may result in decreased water levels of mangrove forest resulting in increasing salinity of these mangroves water. This increased salinity may pose danger to the most threatened mangrove forests of Pichavaram.

Although there are many reserve forests around Jayamkondam area, but most of the reserve forest are under plantation forestry wherein only one or very small number of species exist, which are commercially important. Eucalyptus has a major share (over 50%) of the total plantations. Part of the area is under cashew (Anacardium occidentale) and other miscellaneous types. We were also told that the small patch of forest in which we undertook enumeration will also be covered to plantations in a year or two. Therefore there is no threat to biodiversity in total or to any particular species which is endangered or in the verge of extinction.

Chapter 7. Environmental management plan

7.1 Introduction

Because of the projected increase in lignite production and power generation and other related activities in the area, generation of waste loads, land occupation, displacement of population and noise levels would increase in the future. An area-wide environmental quality management (AEQM) plan requires,

- setting of desired environmental quality targets that one would like to achieve, and
- developing a list of feasible control measures that will improve the ambient environment

For this study, the targets can be taken as the standards for various parameters prescribed by the enforcement agencies. As brought out in the previous chapter, the concentration levels of different pollutants affecting the air quality are observed to be well within the prescribed standards assuming basic control measures like ESP in power stations. The surface water quality is also within the prescribed limits for the best designated use provided certain base set of control measures like sedimentation tanks are installed in power plants and mines. The predicted noise levels due to increased activities are also observed to be within limits. The most important impacts were identified as land occupation, displacement of population, and lowering of ground water levels. The control measures for the protection of soil, water, air, affected population, and ecosystems are discussed in the following paragraphs.

7.2 Control measures for air quality

All future power plants in the area would have electrostatic precipitators (ESP) with a design efficiency of 99.5%. Stack details for the each of the proposed power plants (upto 2020) are given in Table 7.1. The remaining units of TPS I where mechanical dust-collectors (MCD) are in operation would be replaced by ESPs in 1995. Steam generation plants would continue with the existing control measures.

Table 7.1. Details of ESPs for future power plants

Stack details			Type of control	Year of installation
Number	Height (m)	Internal diameter (m)		
TS 1 expansion				
Stack 1	220	4.93	ESP	2003
Stack 2	220	4.93	ESP	2003
STCMS				
Stack 1	220	5	ESP	1998
Stack 2	220	5	ESP	2003
Stack 3	220	5	ESP	2003
TS A/B				
Stack 1	275	5.07	ESP	2012
Stack 2	275	5.07	ESP	2013
Stack 3	275	5.07	ESP	2013
Stack 4	275	5.07	ESP	2016
TS JK				
Stack 1	275	5.07	ESP	2000
Stack 2	275	5.07	ESP	2001
Stack 3	275	5.07	ESP	2005

Note:
All ESP's are designed for 99.5% efficiency.

7.3 Water

7.3.1 Ground water quantity

Forecasts of future water demand suggest that management of the groundwater basin is very essential by regulating the inflow and outflow from the basin The management objective consists of providing an economic and continuous water supply to meet a usually growing demand from an underground water resource of which only a small portion is perennially renewable.

Artificial recharge of Groundwater

In Neyveli, natural recharge due to infiltration of the rainfall precipitation is the major component of the annual input in comparison to the seepage from other sources like surface water bodies and irrigation. In recharge zone, the recharge takes place to the phreatic acquifers which are hydraulically connected to the confined acquifers. Hence, the recharge measured is the actual input to the confined groundwater reserves. The study done by "National Geophysical Research Institute" in 1989 reveals the above facts of hydraulic connection of the phreatic acquifer to the confined acquifer.

Recharge measurements (Present Scenario)

Recharge area = 420 Km^2
Width of Recharge area = 15 Km (approximate)
Annual rainfall(average) = 1160 mm
Infiltration rate from surface = 15 % (Recharge zone)
Total available water = 1.160 X 420
= 487.2 MCM/Annum.
Therefore, Total recharge volume = 73.08 MCM/Annum @ 15% infiltration rate, and
Surface run off (from recharge zone) = 414.12 MCM/Annum @ 85% of total precipitation.
Travel distance of run off water (to sea) = 30 Kms
Rate of infiltration during travel to sea for every 10 Kms = 10 % (higher rate of discharge)
Hence, Total infiltration (%) = 45 % (15% + 10% X 3)
Infiltered volume = 151.2 MCM/Annum
Evaporation Losses (1994) = 4.3 mm
Total (%) run off to the sea = 55 %

From the above calculations it can be observed that more than 50 % of the total rainfall falling over the whole area enters into the sea as surface run off. Physiographically, Neyveli area falls under three broad units of classification namely - Northwest highland, Central high ground and flat topography in South and South-eastern region. The Northwest highland and central high ground ranges in elevation from 30 m to 100 m above mean sea level. Hence, in the light of the physiography of the region construction of a series of basins, parallel to the natural stream channel, becomes advantageous. Among the variety of methods developed for recharging ground water artificially, the most viable method appears to be the water spreading method subclassified as "basin type water spreading" method.

Now, we will draw a model exercise for a 100 m X 100 m basin/percolation tank.
Defining the variables,
Horizontal Permeability (HP) = 0.003 m/sec
Vertical Permeability = 1/10 * (HP)
= 0.00003 m/sec
Surface area = 10,000 m^2 i.e (L * B)
Therefore, Volumetric recharge Quantum = 10,000 * 0.00003
= 0.3 m^3/sec
Tank Specifications as per above decided model
Length = 100 m
Breadth = 100 m
Area = 10,000 m^2
Height = 1 m
Therefore, Volume = 10,000 * 1
= 10,000 m^3
The rate at which the water from tank would move down
= 10,000/0 3
= 33333.33 sec
= 9.26 hrs.

Therefore, in 9.26 hrs 0.01 MCM of water from basin would percolate into the ground in ideal conditions.

Assumptions

- Assuming rainfall occurring for 15 hrs a day for any 90 days in a year comprising of North east and South west monsoons.
- Since, the above 90 days would be cloudy days, hence evaporation losses would be minimum.
- The height of tanks is 1 m. In case of overflow the water would get to the surface or to the other tank arranged in series. Hence, the tanks are taken to be at their maximum holding capacity for these 90 days.

Based on above assumptions the total quantum of recharge,
= 0.3 * 60 * 60 * 90 * 15
= 1.458 MCM/Annum

Presently, for the same area of 10,000 m^2 the quantum recharge adding to ground water (15 % infiltration)

= 10,000 * 1.16 * 0.15

= 0.00174 MCM/Annum

Present balance reveals that about 160 MCM of ground water is extracted in excess to its recharge quantum.

Therefore, number of tanks required to balance the excess pumpage

= 160/1.458

= 110 tanks

Since, the above calculations are performed for a tank of 10,000 m^2 the total area acquired by all 110 tanks would come out to be 1.1 sq.km. in comparison to the total recharge area of 420 Sq.km.

Constructing a tank of area 200 m X 200 m would reduce the number of above calculated 110 tanks to 30 (i.e to one-fourth approx).

To make the above approach applicable following additions are necessary,

Recharge well construction in the basin

This would help in quick admission of water from the surface basin to acquifers. This would form a cone of recharge theoretically reverse of the cone of depression. However, the difficulties generally encountered include:

- Clogging of acquifer surrounding the well due to silting.
- Reduction in the permeability of the acquifer due to air binding i.e carry away of dissolved air into the acquifer system.
- Reduction in the flow area due to presence of bacteria in the surface water thus forming growths on well screen.
- Deflocculation caused by reaction of high sodium water with fine soil particles.

These factors which all act to reduce recharge rates, need to be eliminated to the maximum. Favourable recharge rates can been adopted through following techniques:

- Chlorination and deaeration of the water supply.

- Providing a concrete sealing on the outside of the casing particularly where it passes through the impermeable zone above the confined acquifer.

Seeing the practical implication, it would be better to construct a **grit channel before the percolation tank.** This channel would arrest the silt carried by the run off storm water and moreover provide for the uniform non-turbulent and non-eddy flow of water, thus preventing the carry away of dissolved air into the acquifer system. Moreover, it would allow the provision for chlorination of the storm waters.

Design of Grit Channel
Specific gravity of grit = 2.65
Minimum diameter of grit removed = 0.15 - 0.2 mm.

The grit chamber is designed for a surface loading of 30 m/hr
Average volume of grit = 0.1 m^3 / 1000 m^3
Maximum horizontal Velocity = 0.2 m/sec
Surface loading "SL" = Q/A
= 20,000 / 30
(Assuming the total flow to be 20,000 m^3/d)
Therefore, Area = 28 m^2
Hence, choosing length of grit channel = 15 m
breadth = 2 m
Area = 30 sq m (OKAY)
Detention time = 15/0.2
= 75 sec
Let the depth be 1 m
Therefore, $V_{horizontal}$ = 20,000 / (1*2*1)
= 0.1 m/sec

Design of influent channel to the grit chamber
Flow = 20,000 m^3/d
= 0.23 m^3/sec
Non-settling velocity of grit = 1.5 m/sec
Therefore, Cross Sectional area of channel required = 0.231/1.5
= 0.154 m^2
Choose, breadth = 30 cm
Depth = 50 cm

The overflow weirs are desired for the overflow rate of 30m/hrs Therefore, the grit chamber before the tank of area 10,000 m^2 would have following specifications:

Length	=	15 m
Breadth	=	2 m
Depth	=	1 m
Designed horizontal velocity of water	=	0.1 m/sec
Minimum diameter of grit/sand/silt removed	=	0.2 mm

Carrying out a very limited pumping operation in the vicinity of the tank

This would help in the movement of water through the "zone of aeration". However, the distance between the pump and the tank,and the quantum of water pumpage should only be arrived at after carrying out field tests.

7.3.2 Ground water quality

As discussed earlier, the ground water is chemically soft in nature with low dissolved mineral content. The iron contents vary from a very low value to 1 mg/lt. However the pH for most of the samples are on the acidic side ranging from 5.5 to 6.3 which is objectionable for drinking water.

Occasional discoloration and odour is noticed in the water which may be due to the corrosion of iron pipes or disturbance of existing deposits in the pipelines or in the overhead tanks.

Bacteriological quality of ground water is satisfactory, but sometimes also shows presence of coliform organisms.

There is a need of taking corrective measures so as to bring the above parameters within the acceptable levels to avoid any adverse health effect among consumers and damage to the distribution pipelines.

As a measure of sanitary safeguard it is advisable to subject all the borewell waters to adequate disinfection by regular chlorination in the over head tank using bleaching powder. Chlorination using bleaching powder not only ensures bacterial safety but also is advantageous in improving the clarity of the water. It would also bring the acidic pH values of the borewell waters within the desirable limit on account of its lime content. The dosing which is essentially needed is 4 - 5 gms/kl and a retention of minimum 30 minutes for ensuring complete reaction and disinfection.

In order to take care of the occasional discoloration and odour, the overhead tanks where the water is stored before distribution need to be periodically cleaned using a strong chlorine solution. This would prevent the deterioration of water quality. The pipelines serving the area also need to be thoroughly flushed out and checked for leaks.

7.3.3 Surface water - desilting of surface tanks

The state of Tamil Nadu has an interactive tank system, built centuries ago for bringing about highly profitable irrigation. This system of connecting a series of tanks by channels, enabled the flow of water from the highest point (elevated area) to lowest point (downstream area) via series of tanks. This process of regulating the flow of surface water through channels and tanks is highly efficient since it results in proper storage of water and thereby prevents surface run-off. Due to the increase in the retention time of the water, it also results in an increase in infiltration quantum into the ground, and prevention of water logging

Maintenance operations for these tanks are undertaken by the public works department and other local authorities, and many a times by the local people themselves. But, majority of these tanks still lie neglected and completely ignored, resulting in uncontrolled flow of water into the fields, heavy soil erosion, damage to crops, and, of course, loss of precious water.

Neyveli sub-area is comprised of a large number of tanks, both small and large, the major ones being Walaja tank, Perumal eri, Veeranam tank, Peria eri, Jumbo eri, Kathazhai eri, and Arappa eri. Out of these, the tanks of interest from NLC's ongoing activities point of view with huge catchment areas and large ayacut areas include Walaja tank, and Perumal eri.

The flow diagram showing the loadings of TSS (discussed in chapter 4), reveals that approximately on an average 15-20 tonnes per hour of TSS enters Walaja tank (inlet), while the analysis of outlet water (inlet to Perumal eri) shows TSS in the range of 6-12 tonnes/hr. Hence, about 8-

10 tonnes of TSS settle down per hour in the tank as well along the 7 km long water course to Perumal eri.

In other words, about 0.1 million tonnes per year of solids are deposited partly in the tanks, and rest along the water course.

For the last number of years villages situated along Perumal eri for example Kannadi, are experiencing flooding of their fields, water logging during the post monsoon period while water scarcity during the pre monsoon period.

Taking the depth of Walaja tank into consideration, which is around 0.6 m, and average particle size as 0.2 mm, it is estimated that the desilting operation of the tank and channels should be carried out in every three years.

7.3.4 Control measures for effluents

Summary of the control measures being planned for effluent streams are given in Table 7.2.

Table 7.2. Future control measures for effluent streams from industries

Industry	Discharge volume (m^3/hr)	Treatment	Type of treatment	Impact
Power plants				
TS 1 expansion	460	Ash pond	Primary	Insignificant
STCMS	725	Ash pond	Primary	Insignificant
TS-A/B	1860	Ash pond	Primary	Insignificant
TS-JK	1391	Ash pond	Primary	Insignificant
Industry				
Fertiliser	210	Recovery of ammonia vapours by use of stripper section	Secondary	Insignificant
B&C	404 5	Equilisation tank, flash mixer, primary clarifier, aeration tank, secondary clarifier	Secondary treatment for phenols	Insignificant from the stream from by-products recovery plant

7.3.4.1 B & C plant - treatment modification scheme for ETP

Source of pollutants and wastewater in B & C plant

- Floor washings: Floor washings to keep the floor free of settled/ spilled lignite from conveyors and launders contribute to wastewaters containing suspended and settled lignite dust in drain channels.
- Quench water: Quench water sprayed on the carbonised briquettes carry good amount of suspended solids.
- Cooling lower bleed: The cooling water used for vacuum pump in the vacuum distillation unit contains phenols.
- Spray water: The spray water on cooling screens in the coke handling plant contains coke dust.
- Lean liquor: Lean liquor is the predominant phenol containing wastewater generated from the pheno-solven plant in the tar product unit

Overall view suggests that phenol containing streams are only restricted to the carboniser and tar product recovery units. The coke handling plant and briquette unit effluents contain more of suspended solids.

The biological treatment plant (BTR plant) installed functions to remove the organic impurities, toxic in nature, which cannot be discharged untreated into the stream.

The material balance of phenolic wastewaters to BT plant is as follows:

Lean liquor	: 17 m^3/hr (from pheno-solven plant)
Sludge water	: 209 m^3/hr (carboniser cooling lower bleed)
Raw water	: 24 m^3/hr (raw water/ quench water)
Total	: 250 m^3/hr
BOD	: 700 mg/lt
	: 3528 kg/day
Phenol concentration:	200 mg/lt
Total phenols	: 1200 kg/day
Temperature	: 45°C
Suspended solids	: 370 mg/lt

Performance analysis of BTR plant based on sample analysis results

- The results show that there is a drastic fluctuation in the inlet concentration of phenol (organic matter) ranging between 30 - 300 mg/lt. This amounts to the microbial culture in the aeration basin being subjected to operational loads which is detrimental to the growth pattern of the microbial population thus resulting in causing operational upsets in the plant.

- The results also indicate that perhaps the nutrients are not added according to the required proportions:

  BOD: N: P = 100: 5: 1, resulting in the decreased multiplication of the microbes thereby reducing the MLSS concentration.
- The inlet concentrations of BOD also show drastic fluctuations varying between 10 - 18,600 mg/lt. Even the clarifier outlet results of BT plant for the same time periods indicate very high BODs levels, 180 - 4260 mg/lt.
  The results reveal that the significant reduction in phenolic concentration does not correspond with the reduction of BOD levels implying the presence of organics other than phenol in the effluent stream. This could possibly include fatty acids which are not degraded properly.
- The total suspended solids in the clarifier outlet streams show a very high value, ranging between 270 - 1600 mg/lt against the standard limit of 100 mg/lt. This implies that the clarifier unit is not able to remove the solids present in suspended state and hence suggests that it needs to be revamped. Though the agents which increase the flocculation rates like $FeSO_4$ are added, it seems that the required conversions are not achieved. The BT plant details also show that calcium hydroxide is added to increase sludge settleability but perhaps the cells i.e. microorganisms are not able to meet optimum mean cell residence time 'Θc'. Other reason could be large values of sludge volume index or SVI, in the aeration tank.

On analysis the view, it can be concluded that BT plant is capable of bringing down the phenol concentration, but is incapable of reducing BOD concentrations.

Defining functional relationship of BOD with other parameters,

BOD = f (DO, Organics, TSS, TDS, O&G, pH, phenol) (A)
Organics = f (TSS, TDS) (1)

As seen from results, reduction in phenols doesn't result in reduction of BOD, hence for the given system.

BOD # f (phenols) (2)

The pH of the system is in the range of 6.5-8.5, which is fine. Hence for this system we delete the parametric dependency of BOD on pH (3)

Applying (1), (2), and (3) to (A)

BOD = f (TSS, TDS, O&G, DO) (B)

One thing which can be said is that the air requirements of the system are met adequately by aerators, since otherwise the oxidation of phenols wouldn't have taken place.

Hence, finally we get

BOD = f (TSS, TDS, O&G)

The above equation suggests that measures should be taken to remove solids from the tanks. It also suggests the removal of O&G. These modifications need to be brought in the existing system.

Stagewise operation of set-up

- Induction of gravity oil separator
- Induction of flash mixer with residence time of 5 minutes and rapid turbulent dosing of flocculating agents followed by mixing using high RPM aerator.
- Induction of primary clarifier with surface loading of 10-25 m^3/m^2 day and residence time of about 2 to 2.5 hours This will help in keeping the ratio of MLVSS to MLSS constant to 0.65.
- DO concentration in the aeration basin to be kept around 1-2 mg/lt.
- A V-notch should be inducted between the outlet and inlet points with the establishment of flow rate and consequently the feed rate, it would be possible to establish the monitoring parameters like volumetric loading, F/M ratio, Sludge recirculation ratio, Oxygen PPM etc.

The above mentioned operations have been discussed as follows:

- Induction of gravity oil separators

Gravity oil separator unit should be employed before the flyash mixer. The unit is very important because oil, tar and/ or grease if enter the aeration system, will hamper the activity of microbes. Oil is separated from water by using the difference in specific gravity between them.

The treatment of oil containing wastewater depends on the oil drop diameter (see table below).

Table 7.3. Gravity oil separators based on the oil drop diameter

	Unit	API oil separator	PPI oil separator	CPI oil separator
Oil drop diameter	μm	> 150	> 100	> 60
Mean velocity in tank	m/min	0.9	0.6	0.28
Rising velocity of finest oil droplet	mm/s	0.9	0.2	0.2
Oil content in inlet	mg/lt	1000	1000	1000
Oil content in outlet	mg/lt	≤ 30	≤ 10	≤ 10

API oil separators would prove better to be in use.

Design of Primary Clarifier Unit
They are designed for the removal of 35-40 % of the organic matter.

The unit is designed for a surface loading of 10-25 m^3/m^2 day.
Residence Time = 2 hours.
Design flow in the clarifier (Q_D) = 250 m^3/hr
SLQ = 1.04
= 1.2 m/hr
Area required = Q_D / SLQ
= 250 / 1.2
= 208 m^2
For a circular primary clarifier, area = $(22/7*4)/D^2$
Let D = 17 m
Total Area = 227 m^2
Taking Detention Time = 2 hours
Taking required Volume = 500 m^3
Therefore, Depth = 500/227
= 2.2 m
Circumference of clarifier = 22/7 * D
= 22/7 * 12
= 53.4 m

Supernatant flow velocity from the supernatant duct
Along the diameter = 250 / (3600 * 2.2 * 17)
= 0.002 m/sec
Along the total circumference = 0.0006 m/sec
Design of Inlet/outlet channels

To avoid any possible sludge accumulation the inlet channels are designed for a minimum velocity of 0.1 m/sec
Length of inlet channel = 10 m
Therefore required cross sectional area = 0.002/0.1
= 0.02 m^2

Provide a channel with 10 cm depth and 20 cm width with 3 cm depth inlet weir.

Similarly outlet channels should be constructed from supernatant duct leading to the aeration tank.

Provide a circumference of 13 m and depth of 1 m. The diameter of the hopper would be 4 m.

The sludge is being continuously removed by hydraulic suction. The following are the design specifications of the BT plant.

- Setting basin : I and II
  Capacity : 3000 m^2
- Aeration basin
  Capacity : 2890 m^2
- Aerator : 4 VORTAIR aerators
  Diameter : 3.6 m
  Circumferential speed : 4.3 m/sec at 23.9 RPM
  Immersion : 7.5 mm
- Clarification basin
  Capacity : 865 m^3
  Area : 485 m^2
  Water depth : 2.3 m
- Recycle type sludge pump
  Type : Horizontal screw
  Capacity : 200 m^3/hr
  Speed : 710 RPM
  HP : 3

- Sludge disposal pump

Type : Paddle type rotary
Capacity : 20 m^3/hr
Speed : 1240 RPM
HP : 3 7

At present the agents which bring flocculation and increase the settling characteristics are added to the stage where aeration tank operates.

The theory being the flocculation by the addition of flocculation agents involves initial high turbulent mixing for about 5-7 minutes followed by gentle stirring to allow the particles to increase their contact time and hence form flocculants. This phenomenon also governs surface charge of dissolved particles.

In order to bring initial high turbulence, flyash mixers are used with dosing facilities. Hence, known quantities of agents are added to the system and flyash mixed for 3-5 minutes time This requires only one aerator of high RPM functioning in a small sized tank, the size of tank being or of the order of the dimensions of aerator (circumference).

This is followed by primary clarifier unit where gentle stirring takes place. The circular clarifier would be preferred for this system. The retention time is generally 2 hours. The output of flyash mixer should go to primary clarifier, whose output in the form of supernatant wastewater should go as an inlet to aeration tank.

At present, the particles whose surface charges have been altered (zeta potentials) are not getting time to flocculate because in aeration tank the contact time between particles is less and moreover due to high speeds of aerators the bridging effect is completely destroyed. Hence a primary clarifier is very essential along with flyash mixing.

Moreover, a primary unit like this can also arrest fluctuations in the phenolic concentrations of the influent, which are at present directly influencing the vital microorganisms responsible for conversion in the aeration tank. Being a biological treatment systems, it is very sensitive t the fluctuations/ upsets, in which case the entire contents of the aeration basin may have to be discarded. The main aim should be to avoid the occurrence of such accidents, but, if they occur, it is necessary to keep a buffer or an additional seeding unit ready with a ready acclimatized culture. The seed unit should run parallel to the main unit with the same set of operations.

7.4 Noise control measures

Walls or barriers located in the transmission path between a source and receiver can provide significant noise reduction. Noise attenuation by vegetation is highly variable and depends upon the nature of the ground surface, the type and structure of vegetation and the height of the source and the receiver above ground. The green belt of minimum 50 m width with 6 m height could attenuate the noise level of about 6 dB(A) for an average frequency of 2000 Hz. By designing the green belt around the proposed mines and power plants in Neyveli, Jayamkondam and Bahour regions, the noise level could be reduced sufficiently Further improvement of noise level scenario would be possible by keeping the external overburden dump in between mining and the settlements.

The higher noise level of 110, 95, 97 and 100 dB(A) was observed in turbine hall and operators cabin of drilling, dozer and bucket wheel excavator respectively. By providing the hood (enclosure) on turbine generator, the noise level could be reduced. It was found that the door of the hood available with the turbine remains open and by keeping the door tight, the noise could also be reduced. Workers should be provided with ear muff, ear plug or helmet to work in the turbine hall whenever required.

Noise level in operator's cabin of bucket wheel excavator, drill and dozer machine was observed to be higher because the cabin was not properly enclosed. To reduce the noise level in the operators cabin, it must be properly enclosed on all sides, with sound absorbing materials inside the cabin. The acoustic absorbing materials that are most effective for low frequency sound absorption are acoustic tiles, rugs, glass fibre etc. whose absorbance coefficient are in the region of 0.99. The cabin should be properly ventilated and its temperature controlled.

Importance should be given to reduce the noise of heavy mining machinery at the design stage. The machines should be maintained regularly to keep the sound pressure level within safe limit. The silencers and mufflers should be used to reduce the noise level at the source.

7.5 Ground level vibration

Ground level vibration is an inevitable consequence of blasting operation in mines and therefore, it has been identified as one of the sources of environmental hazards. Proper selection of blast design, explosive and charge per delay plays an important role towards control of blast vibration in mines. As single and double storey residential buildings having their natural frequencies, resonance effect due to ground motion is to be taken into account while deciding safe limits of blast vibration. The wave propagation equation needs to be developed for existing and planned mining conditions to obtain the safe vibration level.

7.6 Ecosystem and Landscape

7.6.1 Land reclamation

The restoration plan for existing and future mining projects upto 2020 as worked by M/s LAUBAG is as follows,
Mine 1 - 1744 Ha
Mine 2 - 1530 Ha.

The land restoration plan for the mining projects covering the total life period of each mine are given in the Table 7.4

NLC Ltd., is also preparing reclamation plans for mine 1 and 2. Due to the expansion plan for mine 1 (from 6.5 Mt to 10 Mt), the overburden material is being dumped on the existing external and internal dumps, thereby, increasing the height of these dumps. In the next 3 to 5 years, reclamation activities will be suspended in mine 1 due to the expansion scheme. On receipt of the future plans from NLC Ltd., we would prepare the reclamation plan for mine 1, mine 2, and block B mine.

Table 7.4. Restoration plan for mining projects (Figures in Ha)

Opencast	Total	Agriculture	Forest	Waterbody
Mine 1	3673.0	799.6	1692.2	1081.2
Block A	1166.7	661.9	200.2	393.6
Mine 2	4948.6	2816.6	1938.7	194.4
Block B	3076.0	1927.7	617.6	629.8
Mine 3	3672.1	1972.2	963.4	636.6
South Vellar	4896.0	1711.0	2190.8	793.2
Neyveli	21432.4	9889.0	7602.9	3728.8
Jayamkondam-Northfield	3546.1	980.6	2366.6	209.1
Jayamkondam-Southfield	2806.6	968.0	1149.6	699.1
Jayamkondam	6352.7	1948.6	3516.2	908.2
Bahour	4675.0	2110.0	1828.6	736.6
Grand Total	32460.1	13947.6	12947.7	5373.6

7.6.2 Ecological restoration from the dump and marginal areas

Under preparation

7.6.3 Green belt design

Under preparation

7.7 Protection of population

7.7.1 Rehabilitation of displaced population

Existing NLC's rehabilitation package

The population likely to be displaced/affected by mining operations till 2020 is estimated at about 8000 families for a land occupation of 3032 hectares. Displaced families fall under Category I and II and the affected families fall under Category III and IV. The existing rehabilitation package offered by NLC to the displaced and affected population is given below. In addition NLC meets the development cost of the rehabilitation colonies.

- monetary compensation for land
- house compensation
- 30% of value of land as solatium in consideration of compulsory nature of land acquisition
- interest at the rate of 12% per annum on the entire compensation accruing from the date of notification till date of award
- plot of land of 0.05 acre in the rehabilitation colony
- resettlement charges Rs.5000/- per head
- transporting of salvaged house material to the rehabilitation colony.

Rehabilitation package in Coal industry

The rehabilitation package offered in coal the industry is also similar to Neyveli project except for the following additional benefit;

- families which are not beneficiaries of employment for one member of the family are paid an economic compensation for 20 years at the following rates;
    - Families losing land upto one acre: at the rate of Rs 300/- per month, plus an ex-gratia amount of Rs 100/- per month per family
    - Families losing above one acre: Rs 300/- per month per acre subject to a maximum of Rs 1000/- per month plus an ex-gratia amount of Rs 100/- per month per family
- vocational training to be provided for one third of the affected population to help them in upgrading their skills. This would cost about Rs.10,000-15,000 per person.

Rehabilitation package in River valley projects

River valley projects have relatively well laid out R&R policies, norms (for land acquisition and structures) and guidelines. During the clearing of the project, the Central Water Commission (CWC) decides based on the following provisions:

- Acquisition of land (private/government) for works and that coming under submergence
- Compensation of other properties like houses, wells, trees, etc - the cost of wells should be based on the evaluation of their numbers and present day costs: but the cost of structures such as buildings, temples, etc should be based on plinth area rates at present day cost less value of usable materials
- Compensation of standing crop is not uniform, but is normally made at a suitable rate per hectare of land cultivated
- Interest at the rate of 12.5% per annum on the compensation from the date of notification till date of award
- Solatium charges for compulsory acquisition at 15% of the cost of compensation
- Legal charges
- Relocation of communications like roads, railways, telegraphs lines, etc
- Rehabilitation measures
- Staff for demarcation measurement of land
- Establishment charges for land acquisition and rehabilitation - establishment charges are generally provided at 6-14% of the total cost of compensation. In addition to this, provision is also required for labour and materials for demarcation and measurements for land and properties @ 1% of the cost of land

Views of affected population on NLC's existing rehabilitation package

A survey was conducted to assess the views of the affected population and it is observed that people look forward to

- fair and just compensation for their land being acquired taking into account the appropriate market value
- compensation for the standing crop at the time of acquisition
- job opportunities in the project
- adequate facilities in the rehabilitation colonies and the rehabilitation colonies should be close to their villages.

Based on these factors and the various provisions in other packages mentioned above, NLC can consider including the following to their existing rehabilitation package;

- economic compensation to families losing land which are not beneficiary of employment to one member of the family (similar to Sonepur Bazari package)
- compensation of standing crop
- vocational training to be provided for one third of the affected population to help them in upgrading their skills. This would cost about Rs.10,000-15,000 per person.
- Scholarships to eligible students in secondary/higher secondary level for pursuing higher education.

7.7.2 Disaster planning and risk management

Thermal power station

Disaster in a power plant can be classified into two categories namely industrial and natural. Industrial disaster could be due to fire and explosion and natural causes could be floods, cyclones, etc. Disaster is an emergent situation which affects one or more departments and/or personnel working therein, resulting in extensive damage to the property, injury/loss of life and disruption of work. The development of an effective disaster management plan is, therefore, essential to ensure that unforeseen identified impacts are minimized.

Objectives of a disaster management plan

The objectives of the major emergency plan is to make use of the combined resources of the power plants and the outside services to:

- Effect the rescue and treatment of casualties.
- Safeguard other people.
- Minimize damage to property and the environment.
- Initially contain and ultimately bring the incident under control.
- Identify any dead.
- Provide for the needs of relatives.
- Provide authoritative information to the News Media.
- Secure the safe rehabilitation of affected area.
- Preserve relevant records and equipments for the subsequent enquiry into the cause and circumstances of the Emergency.

Disaster management requires the support and involvement of various external agencies such as the local police, fire and civil defence departments, hospitals, state pollution control boards, etc. The DMP specifies responsibilities of various officials in the plant, agencies to be alerted, communications to be established, notification to the general public, and also as to when and how to terminate the emergency. In the major emergency situation, following resources over and above those available at the unit will be needed.

- Supply of Fire Fighting equipment.
- Breathing apparatus.
- Specialized equipment.
- Medical supplies.
- Manpower.

Organizations required in the plant for dealing with emergency

Fire station

A regular fire brigade manned by well-trained fire fighting personnel with adequate equipments should be provided. Major equipments to be provided are:

- Mobile water tank of adequate capacity
- Mobile trailer pump unit
- Foam monitor of 1000 litre capacity
- A booster pump for supplying water at high pressure to the foam monitor
- A network of fire hydrant mains with fire hydrant points in areas like powerhouse, boiler, fuel pump house, lignite storage bunkers, transformer yard, etc.
- Portable fire extinguishers at strategic locations

Emergency control centre

An emergency control centre should be located at the General Manager's Office. It is the focal point from where operations to handle the major emergency are directed and coordinated.

Emergency siren to be provided at a suitable location. Once the emergency siren is raised, the works emergency procedure should be activated.

Emergency key personnel

- Site Controller - General Manager: On hearing the emergency siren he will proceed to the emergency control centre and will take overall charge of the situation.
- Incident Controller - Shift Incharge:
- Liaison Officer - Senior Personnel Manager:
- Communication Officer - Staff Officer (Technical):

- Safety Officer
- Medical Officer
- Fire Officers and Security Officers

Responsibility chart for these officers has to be prepared. In addition, certain employees categorized as essential workers should be trained to discharge their functions at the time of major emergencies. They include Plant Supervisors, Essential Operators, Pump Attendants, First Aiders, and others.

Risk analysis

Disaster is an undesirable occurrence of events of such magnitude and nature so as to adversely affect production and/or cause damage to environment. Risk assessment forms an integral part of "Disaster Management" as any realistic "Disaster Management Plan" could only accrue through a scientific risk assessment. With the advancements in technology, large industrial installations have become extremely complex Any major failure or a number of comparatively minor failures could lead to a disaster taking a heavy toll of human life and affecting the production target considerably.

It is therefore, necessary to ensure safety and reliability of any new plant, through a systematic study of industrial installations based on mathematical methods, to identify possible failures and prevent their occurrence before they actually cause disasters or production losses. All industries should conduct reliability studies while proposing new installation in order to evaluate safety of installation and identify, quantify and minimize risks. Risk analysis consists of following two parts viz. risk identification and risk assessment.

Risk identification

Risk identification can be as simple as asking "what if" questions at design reviews. Other methods are to use a check list of the normal process hazards associated with a particular piece of equipment. Quite often, a checklist is merely a summary of the important "what if" questions that arise during design reviews.

Risk assessment

Risk assessment techniques are:

- Hazard and Operability Study (HAZOP)
- Fault Tree Analysis (FTA)

- Monte Carlo Simulation
- Safety Audits
- Safety Indices

7.8 Solid waste management

Mining and Thermal Power Stations are the major industrial activities in the study area. From these activities solid waste generation is in two forms, viz. ash (from power stations), and overburden (from mining)

Overburden handling has been dealt separately under section 7.6.1. (land reclamation). In this section, fly ash management is discussed in detail

7.8.1 Flyash collection and disposal - Present Status

In the existing power stations viz., TS-1 and TS-2, a hydro-flushing system of ash disposal (HAD) has been used. In this system, the bottom ash and flyash are flushed from their points of collection into an ash slurry sump and the slurry is pumped into a separate ash dump provided for each of the thermal stations. In TS-1, there is also a provision for dry ash collection. At present, fly ash generation from TS-1 is about 0.056 Mt and from TS-2 is about 0.65 Mt per year. Presently, about 22% of fly ash from TS-1 is being sold annually. Very small quantities of fly ash is experimentally being used for fly ash roads construction at Neyveli.

7.8.2 Flyash Utilization Strategies for Future

With proposed power plants under the master plan, it is expected that wet ash generation will increase to a total of 2 24 Mt per year by 2020. A number of indigenous technologies have been developed by R & D agencies and other institutions for gainful utilization of flyash. The utilization range from low value added like use in roads/embankments, mine fill etc. to high value added like extraction of alumina/magnetite, etc.

Flyash properties

Before discussing any utilization option for fly ash from any power station, it is necessary to know/study its properties. Fly ash principally consists of spherical particles with crystalline matter and some unburnt carbon. The colour depending upon quantity of carbon varies from light to dark grey. The specific gravity lies between 1.9 to 2.3 and the bulk density of loose dry fly ash is around 600 kg/m^3. Ash coming from precipitator is medium silt to fine silt. They are basically oxides of silica, aluminium and calcium and together account for 75% to 90% of the material.

Typical details of ash analysis for Neyveli power stations are as follows:

No.	Constituents	% by weight
1	Loss of ignition	1 - 2
2	Silica as SiO_2	45 - 59
3	Aluminium oxide, Al_2O_3	23 - 33
4	Iron Oxide, Fe_2O_3	0.6 - 4
5	Titanium oxide, TiO_2	0.5-1.5
6	Sulphur as SO_3	traces-2.5
7	Calcium oxide as CaO	5 - 16
8	Magnesium oxide as MgO	1.5 - 5

Ash utilization strategies

Use of Wet Ash

- Ash for manufacturing bricks

The fly ash can be used for the manufacture of clay-fly ash bricks, and lined-fly ash bricks. In a recent study conducted by National Research Development Corporation, New Delhi on utilization of Neyveli fly ash, it was reported that this fly ash is suitable for manufacture of bricks. For manufacturing fly ash clay bricks, a fly ash clay ratio of about 30:70 can be used. For manufacturing fly ash lime bricks, fly ash and other material (sand, lime and chemical accelerator) ratio of 82:18 can be used. In both the cases a cold crushing strength of the order 120-150 kg/cm^2 can be easily achieved (it is about 250 kg/cm^2 in case of fly ash clay bricks).

The market penetration of fly ash bricks very much depends on their cost in comparison to the conventional bricks. It was learnt that, in Neyveli area, the conventional bricks cost around Rs.500 - 600 per 1000 nos. Whereas, the estimated production cost of lime-flyash bricks (NRDC) for a 30,000 bricks/day capacity plant is around Rs. 850/- per 1000 bricks However, fly ash bricks are advantageous in terms of the high strength and reliability. Additionally they are based on waste material while red bricks use fertile top soil. Therefore, to attract the consumers and manufacturers, it will be required that

* the price of fly ash bricks to be made competitive with conventional bricks
* disseminate the advantages of fly ash bricks among the public/consumers

From the view of the steps to be taken by NLC to promote fly ash utilization, it is, therefore, felt that NLC management should encourage the entrepreneurs by providing basic know-how, and certain concessions towards infrastructural facilities in the form of

* land for lease at nominal rates
* resources at minimum cost such as water, electricity

Thus help utilizing fly ash for manufacturing value added products.

- Flyash use in roads construction:
  Fly ash can be used as a fill/embankment material and also as a subbase/base material in road construction. NLC has constructed a few stretches of roads in Neyveli township over the past 15 years. A 100 meters stretch in the Main Bazaar road in township was constructed with a 200 mm. thick sub-grade of lime-fly ash-sand mix on top of which a bituminous wearing coat was provided. The performance of the experimental fly ash sub-grade and wearing coat has been quite satisfactory. The savings were approximately 40% when compared to the costs of conventional road subgrade.

  The following points may be considered by NLC:
- Fly ash should be used for all future roads construction in NLC area.
- The possibility of using fly ash in roads construction by State Highways Department should be explored. It is therefore suggested that, NLC could initiate a dialog with the State Highways Department. For example, in the reconstruction of the roads falling under the proposed mines, State Highways Department and NLC could have an understanding to utilize

fly ash. Further, if the State Highways Department is willing, fly ash could be used in all their roads construction activities, as long as it is economical to them.

Use of dry ash

- Fly ash to cement industries

Fly ash can be used for manufacture of portland pozzolana cement (PPC). PPC is made by blending 15-20% per cent fly ash with portland cement of grinding the ash with cement clinker. The portland pozzolana (fly ash) cement is suitable for use wherever ordinary portland cement is used under normal conditions. In Tamil Nadu, presently, some cement industries are manufacturing PPC with fly ash purchased from Neyveli and other nearby power stations.

NLC has been selling dry fly ash (from TS-1) for the past 10 years to cement industries. During 1984-85 about 1,50,000 tonnes of fly ash was sold. In the recent years, the sales have come down and in 1994, fly ash sale is of the order 35,000 tonnes. Table 7.5 gives the details of demand for NLC fly ash from some important cement industries near to Neyveli.

Table 7.5. Future Demand Estimates for NLC fly ash from cement industries

Industry	Distance from Neyveli	Present Capacity (t/d)	Future capacity (t/d)	Future Demand (t/yr)
Present Buyers				
Dalmia Cements, Dalmiapuram	140	1,500	1,500	18,000
Tamil Nadu Cements, Ariyalur	120	1,800	1,800	20,000
India Cements, Sangagiri	400	1,800	1,800	20,000
Madras Cements, R.R.Nagar	450	1,200	1,200	10,000
Chettinad Cements, Puliyur	300	1,200	1,200	12,000
Likely buyers in future				
Dharani Cements, Reddipalayam	100	200	1,800	20,000
Madras Cement, Mathur	120	-	2,000	24,000
India Cements, Sendurai	100	-	3,000	30,000
			Total	1,60,000

The cement industries, at present, are not buying their full requirement of fly ash from Neyveli, mainly due to the high delivered cost (at their plant) of which transportation cost is the main component accounting for nearly 75%. It is learnt that, presently, NLC is charging Rs.45/- per tonne of fly ash. To attract more sales, NLC should consider supply of fly ash free of cost. It is therefore suggested that marketing of fly ash be promoted to increase the sales to cement industries. Suitable incentives may be extended to all buyers/users which may include;

- Fly ash supply free of cost
- Assured supply of fly ash for long periods

- Fly ash concrete and manufacturing aerated cellular blocks, etc.: Technologies are established for use of fly ash for use in concrete and manufacturing cellular blocks. NLC has already initiated and drawn some plans for use of flyash for these purposes.

7.8.3 Future plans for utilization of dry and wet ash from power plants in Neyveli area

The strategy suggested for use of fly ash for various purposes is presented in the following table;

Table 7.6. Annual production and usage proposals for ash in different power plants (Figures in Mt)

TPS	Dry ash			Wet Ash		
	Supply	Use		Supply	Use	
TS-1 (1996 - end of life)	0 32	PPC cement	0 16 (50%)	0 06	CF Bricks	0 021 (35%)
		F Ash Conc	0 08 (25%)		LF Bricks	0 033 (55%)
		Cell blok	0 08 (25%)		Roads	0 006 (10%)
TS-2 (1996 to end of life)	-	-		0 65	CF Bricks	0 227 (35%)
					LF Bricks	0 358 (55%)
					Roads	0 065 (10%)
STCMS (1998 to 2003)	-	-		0 14	CF Bricks	0 049 (35%)
					LF Bricks	0 077 (55%)
					Roads	0 014 (10%)
STCMS (2004 onwards)	-	-		0 41	CF Bricks	0 144 (35%)
					LF Bricks	0 225 (55%)
					Roads	0 041 (10%)
TS-1 Exp (2001 onwards)	-	-		0 21	CF Bricks	0 074 (35%)
					LF Bricks	0 115 (55%)
					Roads	0 021 (10%)

Note:
Figures in parenthesis indicate percentage shares

7.9 Financial aspects

Under preparation

7.10 Environmental auditing

Under preparation

7.11 Organization for environmental management

Under preparation

ANNEXURES

Annexure 2.1. List of water tanks in Neyveli sub-area

No.	Village	Tank name	Ayacut area (acres)	Total depth (Ft)	Storage (MCft)
1	Puliyur	Puliyur	165 78	1 4	27.64
2	Kopavalangudi	Kopavalangudi	106	1 35	17.66
3	Karkudal	Karkudal	212	7 8	17 66
4	Ko-Mavidandal	Ko-Mavidandal	116	2	19.36
5	Ko-Kumarmangalam	Ko-Kumarmangalam	245	6	40 84
6	Gopalapuram	Gopalapuram Vanathi eri	106 38	3	17 74
7	Vilakkapadi	Vilakkapadi	153.23	3 87	25 54
8	Vadakku Vellore	Moopan eri	149 91	5	24.98
9	Gangaikondam	Gangaikondam	219	11 5	36.5
10	Managathi	Managathi	200	3 5	33.34
11	Uyyakondaravi	Uyyakondaravi	226	10 34	37.16
12	Kavanur	Kavanur	150	6 3	25
13	Aziz Nagar	Jumbo/ Peria eri	216	5	36
14	Kolappakkam	Kolappakkam	168	-	28
15	Kottagam	Arasan eri	110	-	18.33
16	Lalpettai	Veeranam	44856	13 05	990
17	Valavanur	Walaja	11392	2	90
18	Kanadi	Perumal	6503	1 6	574

Annexure 2.2. List of water tanks in Jayamkondam sub-area

No.	Tank name	Village	Ayacut (acres)
	PWD tanks		
1	Ponneri	Kuluvarappankoil	1375
2	Pandian eri	Kaatagaram	352
3	Valavan eri	Taludodaimedu	196
4	Kovatattai eri	Karaikunchi	338
5	Sripuram tank	Sirpuram	381
6	Chengalod eri	Vimbakudi	162
7	Sundarenzhi eri	Vangudi	162
8	Vennangudi eri	Radhapuram	350
	Tanks under JK Panchayat Union		
1	Averi	Jayamkondam	90
2	Uyyakondan eri	Jayamkondam	70
3	Naina eri	Kaludindondi	77
4	Peria eri	Taludadaimedu	64
5	Kattu peria eri	Ulukkottai	81
6	Attadi eri	Pranjeri	83
7	Peria eri	Papakudi	53
	Tanks under T Palur Panchayat Union		
1	Peria eri	Vempugudi	61
2	Citteri	Vempugudi	52
3	Timmattan eri	Sathampadi	72
4	Chinna eri	Sathampadi	91
5	Adian eri	Keedanattan	71
6	Seerapu eri	Kunamangalam	53
	Tanks under Udayarpalayam Panchayat Union		
1	Udayarpalayam tank	Udayarpalayam	67
2	Kappakulam eri	Anagarayanallur	52
3	Peria eri	Anagarayanallur	83
4	Peria eri	Gonvindaputtur	96
5	Pudu eri	Anaikudam	67
	New formations by PWD		
1	Endal eri	Edayan	56
2	Karuppangalod eri	Melurtattanur	100
3	Siddamattadam eri	Palayangari	5000
4	Pooraikulam tank	Pichallur	50

Annexure 2.3. List of water tanks in Bahour sub-area

No.	Name of the tank	Capacity (MCft)	Ayacut area
1.	Alankuppam Tank	1.9	55
2.	Aroughour Tank	0.54	51
3.	Aratchikuppam Tank	6.0	75
4.	Arangonour Tank	26.0	313
5.	Arachavak Tank	53.3	790
6.	Adinagapet Tank	26.0	125
7	Bahour Tank	197.6	960
8	Caduvanur Tank	5.4	72
9.	Carasur Tank	12.0	59
10	Cuppam Tank	6.85	278
11.	Chettypet Tank	12.3	90
12.	Cadathur Tank	6.0	71
13.	Caicalapet Tank	2.0	25
14.	Cariamanickam Tank	5.63	115
15.	Caricalampakkam Tank	12.5	185
16	Coroadou Tank	48.2	485
17.	Cudy Irrupalayam Tank	9.0	113
18.	Curivinatham Tank	15.0	183
19.	Eripakkam Tank	2.2	58
20	Embalam Tank Sithen	8.5	155
21	Embalam Vackranery Tank	16.0	212
22	Embalam Vannanery	9.0	120
23.	Irulan Sandhai Tank	27.5	334
24	Kirumampackam Tank	43.0	780
25.	Kijeparicalapet Tank	18.3	223
26	Kanakanery Tank	4.85	180
27	Kadapery of Thondamanatham Tank	5.65	68
28.	Kijesathamangalam Tank	6.80	201
29.	Kijeyour Tank	0.4	14
30.	Kijegrapharam Tank	3.0	38

Annexure 2.3 contd. List of water tanks in Bahour sub-area

No.	Name of the tank	Capacity (MCft)	Ayacut area
31.	Kattery Tank	6.5	66
32.	Kunitchampet Tank (Puthery)	5.0	188
33.	Kunitchampet Pazheri	4.6	77
34	Kattery Payathangal Tank	6.0	33
35.	Karayambouthore Odapery	19.0	231
36.	Kattery Payathangal Tank	4.38	66
37.	Karayambouthore Vannanery	6.5	80
38.	Madagadipet Tank	6.5	155
39	Maducarai Tank	14.5	233
40.	Mannampathangal of Karickalampakkam	1.5	20
41.	Melaparicklpet Tank	9.5	118
42.	Manapet Tank	7.42	285
43	Manamedu Tank	10.8	176
44	Murungapackam Tank	31.0	391
45.	Melsathamangalam Tank	9.3	9
46.	Mangalam Tank	6.5	78
47.	Mannadipet Tank	2.0	30
48	Manalipet Tank	0.78	19
49	Nallour Tank	11.0	133
50.	Nettapakam Tank	12.0	150
51.	Nirnayapet Tank	9.0	110
52.	Ottanthangal Tank	1.0	11
53	Ourrouvaiar Tank	7.0	85
54	Outchimedu Tank	15.0	183
55.	Olandai Tank	14.0	179
56.	Oussudou Tank	540.0	3873
57	Pangour Tank	1.2	78
58.	Perungalour Tank	0.54	36
59	Perungalour Sinnery	2.04	25
60	Pandasojanour Tank	8.9	345

Annexure 2.3 contd. List of water tanks in Bahour sub-area

No.	Name of the tank	Capacity (MCft)	Ayacut area
61.	Pirouvupalayam Tank	9.0	133
62.	Pinnatchikuppam Tank	9.0	115
63.	Pannayadikuppam Tank	16.0	191
64.	Pannayadikuppam Sithen	2.5	30
65.	Pidarikuppam tank	0.75	9
66.	Selimedu Tank	9.0	320
67.	Sannicikuppam Tank	0.7	25
68.	Sorapet Tank	23.9	250
69.	Sompet Tank	13.5	72
70.	Southoukeny Periery	19.0	170
71.	Southoukeny Ottery	15.3	131
72.	Sedarapet Tank	15.0	74
73.	Sorapet Tank (Pudurai)	3.85	25
74.	Sooramangalam Tank	3.0	37
75	Sivaranthagam Tank	10.3	145
76	sedrapet Sithery	4.5	39
77	Thuthipet Tank	9.5	50
78	Thirukanji Tank	6.0	39
79.	Thethampackam Tank	10.25	28
80.	Thirubouvanai Tank	3.5	58
81.	Thiruvandarkoil Tank	2.2	187
82	Thirucknaru Tank Periery	13.0	156
83.	Thirucknaru Tank Sinnery	3.5	45
84.	Thondamanatham Vellery	12.0	143
85.	Vamboupet Tank	10.27	95
86.	Vadanour Tank	28.0	135

Anenxure 2.4. Taluk wise land use details in the study area

Item	Cuddalore	Panruti	Chidambaram	Kattamannarkoil	Vridhachalam	Ullurdurpet
Total geographical area	56645	56097	64882	48223	82247	72940
Forest	-	194	70	941	208	5680
Barren & Unclultivable Land (BUL)	2282	2028	2473	2661	2254	1628
Land put to non-agri uses	9745	6462	6640	65820	11611	11635
Culturable waste	884	256	1214	201	3185	1231
Permanent pasture & other grazing lands	39	46	32	235	229	274
Lands under misc tree crops & groves not included in the net sown area	5017	1988	5213	3546	2652	2091
Current fallow lands	4517	3651	1408	553	4590	5395
Other fallow lands	1761	68	4195	864	8345	1817
Net area sown	32400	41404	43637	33402	49173	43189

Annexure 3.1. Detailed results of respirable dust concentration at different locations of Neyveli, Jayamkondam and Bahour area

Monitoring Dates : 17/12/1994 to 21/2/1995

No.	Station name	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	Mean ±S.D
1	Block-17	59.8	55.6	31.1	36.8	37.4	38.4	27.4	22.7	38.65 ± 12.97
2	Sethiatope	36.3	44.6	36.3	39.6	29.1	42.3	93.2	55.3	47.08 ± 20.12
3	Sathamangalam	55.6	47.4	19.6	28.0	59.4	27.8	55.0	50.2	42.87 ± 15.33
4	Block-29	37.3	27.9	36.8	27.9	20.4	30.4	15.8	18.6	26.75 ± 7.59
5	Kammapuram	25.3	36.6	39.6	36.6	32.4	33.7	55.1	39.0	33.68 ± 10.52
6	Mandarakuppam	52.6	33.0	28.0	33.0	34.6	53.1	34.3	73.5	52.10 ± 18.64
7	Jayamkondam	76.0	79.5	48.2	42.8	93.4	59.6	36.0	34.8	58.91 ± 21.92
8	Tirupanampakkam	45.5	40.5	39.0	42.4	50.1	47.1	38.0	31.0	41.70 ± 5.99

S D - Standard Deviation

Annexure 3.2. List of water sampling stations

NO.	STATION CODE	STATION NAME	TYPE OF WATER	TYPE OF SAMPLE
W1	UML	UMANGALAM	SURFACE	INTEGRATED
W2	WAL	WALAJA TANK	SURFACE	INTEGRATED
W3	PML	PERUMAL ERI	SURFACE	INTEGRATED
W4	PEE	PERIA ERI	SURFACE	INTEGRATED
W5	PVR	PARVANAR RIVER	SURFACE	INTEGRATED
W6	VLR	VELLAR RIVER	SURFACE	INTEGRATED
W7	VEE	VEERANAM TANK	SURFACE	INTEGRATED
W8	SEE	BEHIND BLOCK-16	SEWAGE	INTEGRATED
W9	UDP	UDAYARPALAYAM	SURFACE	INTEGRATED
W10	COL	COLEROON RIVER	SURFACE	INTEGRATED
W11	PON	PONNAIAR	SURFACE	INTEGRATED
W12	MAN	MANIMUKTAR	SURFACE	INTEGRATED
W13	BLK	BLOCK-9	GROUND	GRAB
W14	MAN	MANDARKUPPAM	GROUND	GRAB
W15	SRI	SRIMUSHNAM	GROUND	GRAB
W16	KUR	KURINJPADI	GROUND	GRAB
W17	VAL	VALAIMADEVI	GROUND	GRAB
W18	JK	JAYAMKONDAM	GROUND	GRAB
W19	IR	IRUMLAMKURICHI	GROUND	GRAB
W20	BA	BAHOUR	GROUND	GRAB
W21	M1	MINE I	EFFLUENT	COMPOSITE
W22	BC	BRIQ. & CARB.	EFFLUENT	COMPOSITE
W23	FERT	FERTILISER	EFFLUENT	COMPOSITE
W24	AP-TS-1	ASH POND OF TS 1	EFFLUENT	COMPOSITE
W25	COMB	COMBINED EFFLUENT	EFFLUENT	COMPOSITE
W26	TS-2	THERMAL STATION 2	EFFLUENT	COMPOSITE
W27	IN-TS-1	TS-1 ASHPOND INLET	EFFLUENT	COMPOSITE
W28	BAH	BAHOUR TANK	SURFACE	INTEGRATED

Stations for studying aspect of "Sea Water Intrusion"

Code	STATION NAME AND LOCATION
WS 1	Vadalur Well Water, Vadalur
WS 2	SAL-12, Rasakuppam
WS 3	NRO-16, Kannitamilnad
WS 4	SAL-9, Ramanathkuppam
WS 5	SAL-8A, (South) Mettupalayam
WS 6	SAL-8B, (North) Mettupalayam
WS 7	Portonovo (East)
WS 8	SIPCOT, Kudikadi

Annexure 3.3. Classification of inland surface water, CPCB standard

Characteristics	A	B	C	D	E
Dissolved oxygen (mg/l), min.	6	5	4	4	-
BOD (mg/l), min.	2	3	3	-	-
Total coliform (MPN/100 ml), max.	50	500	5000	-	-
Total dissolved solids (mg/l), max	500	-	1500	-	2100
Chloride as Cl (mg/l), max.	250	-	600	-	500
Colour, Hazen units, max.	10	300	300	-	-
Sodium absorption ratio, max.	-	-	-	-	26
Boron as B (mg/l), max.	-	-	-	-	2
Sulphates as SO_4 (mg/l), max	400	-	400	-	1000
Nitrates as NO_3 (mg/l), max.	20	-	50	-	-
Free Ammonia as N (mg/l), max.	-	-	-	12	-
Conductivity as 25°C (us/cm), max.	-	-	-	1.0	2.25
pH	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.0-8.0
Arsenic as As (mg/l), max.	0.05	0.2	0.2	-	-
Iron as Fe (mg/l), max.	0.3	-	50	-	-
Fluorides as F (mg/l), max.	1.5	1.5	1	-	-
Lead as Pb (mg/l), max	0.1	-	0.1	-	-
Copper as Cu (mg/l), max.	1.5	-	1.5	-	-
Zinc as Zn (mg/l), max.	15	-	15	-	-

A: Drinking water source without conventional treatment but after disinfection
B: Outdoor bathing, organised
C: Drinking water source with conventional treatment followed by disinfection
D: Propagation of wildlife and fisheries
E. Irrigation, industrial cooling, etc

Annexure 3.4. Effluent water standards

Parameter	Units	TNPCB	Standard IS · 2490 (Part 1)-1981	
			A	B
Physical parameters				
Color	(HAZEN)	–	–	–
Turb.	(FTU)	–	–	–
pH	(deg C.)	5.5-9.0	5.5-9.0	5.5-9.0
Temp	(mhos/cm)	40	40	40
Cond.	(mg/lt)	–	–	–
TDS	(mg/lt)	2100	2100	2100
TSS	(mg/lt)	100	100	200
TS		–	–	–
Chemical parameters				
TH	(mg/lt)	–	–	–
Ca as CaCO3	(mg/lt)	–	–	–
Mg as CaCO3	(mg/lt)	–	–	–
ACD.	(mg/lt)	–	–	–
ALK. as CaCO3	(mg/lt)	–	–	–
HCO3 as CaCO3	(mg/lt)	–	–	–
CO3 as CaCO3	(mg/lt)	–	–	–
OH as CaCO3	(mg/lt)	–	–	–
Chlorides as Cl	(mg/lt)	1000	1000	600
TRC	(mg/lt)	–	–	–
Sulphates as SO4	(mg/lt)	1000	1000	1000
Fluoride as F	(mg/lt)	2	2	–
phenol	(mg/lt)	1	1	–
Mn	(mg/lt)	–	–	–
Silica as SiO2	(mg/lt)	–	–	–
Sodium as Na	(mg/lt)	–	–	–
Potassium as K	(mg/lt)	–	–	–
Organic and nutrient parameters				
Dissolved Oxygen	(mg/lt)	–	–	–
BOD	(mg/lt)	30	30	100
COD	(mg/lt)	250	250	–
Phosphates as PO4	(mg/lt)	5	5	–
Oil & Grease	(mg/lt)	10	10	10
Ammoniacal Nitrogen	(mg/lt)	50	50	–
Nitrates as NO3	(mg/lt)	–	–	–
Nitrites as NO2	(mg/lt)	–	–	–
Heavy metals				
Iron as Fe	(mg/lt)	–	–	–
Chromium as Cr	(mg/lt)	2	2	2
Boron as B	(mg/lt)	2	2	2
Zinc as Zn	(mg/lt)	1	5	–
Copper as Cu	(mg/lt)	3	3	–
Pb	(mg/lt)	0.1	0.1	–

In the standards:

Class A: Effluents disposed into the surface waters

Class B: Effluents disposed on land

Annexure 3.5. Ground water standards

Parameter	Units	Standard: WHO		IS-10500 (1991)
		A	B	
Physical parameters				
Color	HAZEN	5	25	5
Turb.	FTU	5	25	5
pH	deg C	7.0-8.5	6.5-9.2	6.5-8.5
Temp	mhos/cm	–	–	–
Cond.	mg/lt	–	–	–
TDS	mg/lt	–	–	–
TSS	mg/lt	–	–	–
TS		500	1500	500
Chemical parameters				
TH	mg/lt	–	–	300
Ca as CaCO3	mg/lt	175	500	75 as Ca
Mg as CaCO3	mg/lt	215	650	30 as Mg
ACD.	mg/lt	–	–	–
ALK. as CaCO3	mg/lt	–	–	200
HCO3 as CaCO3	mg/lt	–	–	–
CO3 as CaCO3	mg/lt	–	–	–
OH as CaCO3	mg/lt	–	–	–
Chlorides as Cl	mg/lt	–	–	250
TRC	mg/lt	–	–	–
Sulphates as SO4	mg/lt	200	400	200
Fluoride as F	mg/lt	0.5	1.0-1.5	1
phenol	mg/lt	0.001	0.002	0.001
Mn	mg/lt	0.1	0.5	0.1
Silica as SiO2	mg/lt	–	–	–
Sodium as Na	mg/lt	–	–	–
Potassium as K	mg/lt	–	–	–
Organic and nutrient parameters				
Dissolved Oxygen	mg/lt	–	–	–
BOD	mg/lt	–	–	–
COD	mg/lt	–	–	–
Phosphates as PO4	mg/lt	–	–	–
Hg	mg/lt	–	–	–
Oil & Grease	mg/lt	–	–	–
Ammoniacal Nitrogen	mg/lt	–	–	–
Nitrates as NO3	mg/lt	–	50-100	45
Nitrites as NO2	mg/lt	–	–	–
Heavy metals				
Iron as Fe	mg/lt	0.3	1	0.3
Chromium as Cr	mg/lt	–	0.05	0.05
Boron as B	mg/lt	–	–	1
Zinc as Zn	mg/lt	–	–	5
Copper as Cu	mg/lt	1	1.5	1.5
Pb	mg/lt	–	0.1	0.1

In the standards
Class A Maximum permissible limits
Class B Maximum allowable limits

Annexure 3.6. Detailed Soil Testing Results

Physico-chemical properties of soils

First Season

	Sample	pH (1 2 5)	EC m mhos/cm	Org Car %	Avail N Kg/ac	Avail P2O Kg/ac	Avail K2O Kg ac	Avail Micronutrients (ppm)			
								Zinc	Iron	Copper	Manganese
1	Near Perumal eri	6 4	0 10	0 22	77	2	34	0 60	13 70	0 40	1 80
2	T V Puttur	7 1	0 21	0.27	87	4	160	0 76	4 40	2 60	3 40
3	Vadakavellur	6 1	0 13	0 30	87	3	80	1 02	26 30	0 12	5 76
4	Muthukrishnapuram	7 9	0 32	0 27	91	3	58	0 57	2.20	0 90	0 48
5	Kallathur	6 5	0 25	0.22	85	3	56	0 71	3.20	0 80	6 10
6	Kuttiyankuppam	8.3	0 12	0 49	101	2	170	0 43	0 80	0 60	0.36
7	Setharpet	7 9	0 15	0 45	99	3	116	0.35	0 70	0 20	0 40
8	NLC Afforestation	5.3	0 09	0.20	76	3	78	0 45	22 00	0 80	27 04
9	Mine I R	5 8	0 06	0 63	116	3	40	0 81	42 90	0 16	3 40
12	Sathapadi	7 8	0.31	0.30	94	3	136	0 45	1 00	1 20	0 64
13	Natchiar pet	7.3	0 08	0.30	82	3	76	0 48	1 80	0 70	1.26
14	Suriyamanar	6 5	0 08	0 40	93	3	82	0 77	0 66	0 12	4 00
15	Bahour	8 4	0 44	0.22	92	3	340	0 65	1 70	2 80	0 44
16	Mine I OB	7 7	0 09	0 13	65	2	24	0 43	1 00	0 20	0 80
17	Mine II OB	8 4	0 12	0 40	92	3	80	0 52	0 70	0 60	0 60

* Samples in stations 10 & 11 (i.e. Mine I unmined and mine-2 unmined areas) were not collected in the first season.

Second Season

	Sample	pH (1 2 5)	EC m mhos/cm	Org Car %	Avail N Kg/ac	Avail P2O Kg/ac	Avail K2O Kg/ac	Avail Micronutrients (ppm)			
								Zinc	Iron	Copper	Manganese
1	Near Perumal Eri	6 9	0 15	0 46	102	8	54	1 68	52 20	2 20	16 68
2	T V Puttur	7 5	0 25	0 73	133	8	211	0 71	43 40	6 00	31 24
3	Vadakavellur	6 3	0 16	0 24	82	10	70	2 01	57 70	1 20	8 16
4	Muthukrishnapuram	7 9	0 25	0 50	110	10	122	0 90	25 30	1 90	22.20
5	Kalathur	6 4	0 06	0 50	102	8	1 26	42 00	2 40	30 80	
6	Kuttiayankuppam	7 4	0 06	0 27	77	8	358	0 83	11 50	2 70	21 56
7	Sedarpet	7 6	0 12	0 32	85	7	206	0 48	5 80	0 90	10 68
8	NLC Plantation	5.3	0 06	0 32	86	5	64	0 34	8 00	1 10	21 12
9	Mine I R	6.3	0 06	0 74	126	15	50	0 88	30 40	0 60	8 52
10	Mine I U	6 6	0 04	0 59	109	7	50	0 91	35 80	1 70	12 32
11	Mine II U	6 4	0 05	0 41	93	7	88	1 20	37 70	2 60	8 64
12	Sathapadi	7 6	0 10	0 41	93	13	148	0 52	14 50	1 80	20 96
13	Nachiarpet	5 7	0 10	0 46	102	9	72	0 53	44 60	2 70	30 20
14	Suryamannar	5.3	0 03	0.27	80	13	104	0 41	27 80	1 40	17 36
15	Bahour	7 5	0 66	0.38	122	16	340	5 78	6 14	8 90	76 08
16	Mine I OB	6 9	0 10	0 27	81	17	28	0 38	1 90	0 50	2 50
17	Mine II OB	6 9	0 04	0 09	60	6	36	0 63	2 20	0 40	0 84

Third Season

	Sample	pH (1.2.5)	EC m mhos/cm	Org Car %	Avail N Kg/ac	Avail P2O Kg/ac	Avail K2O Kg/ac	Avail Micronutrients (ppm) Zinc	Iron	Copper	Manganese
1	Near Perumal En	7.7	0.15	0.36	91	3	82	0.60	28.20	1.50	22.12
2	T V Puthur	7.6	0.07	1.03	152	5	156	0.62	38.10	3.90	25.12
3	Vadakavelur	5.8	0.03	0.54	105	17	78	2.01	49.60	1.00	6.29
4	Muthukrishnapuram	7.8	0.21	0.22	80	3	104	0.64	24.30	1.50	21.96
5	Kalathur	5.6	0.01	0.27	78	2	62	0.63	37.30	1.70	21.68
6	Kuttayankuppam	7.9	0.05	0.49	97	12	272	1.09	12.00	2.10	20.00
7	Sedarpettu	7.6	0.05	0.94	142	2	216	1.02	7.70	1.70	11.08
8	NLC Plantation	4.8	0.04	0.40	94	2	78	0.43	5.60	1.30	16.32
9	Mine I R	5.9	0.02	0.90	140	3	60	0.85	19.20	0.80	11.52
10	Mine I U	5.4	0.13	0.76	133	3	74	1.24	43.90	2.90	8.08
11	Mine II U	7.1	0.03	0.45	94	2	82	1.49	29.40	2.70	11.44
12	Sathapadi	7.4	0.11	0.81	133	10	200	2.36	33.80	3.00	29.00
13	Nachiarpet	6.3	0.04	0.27	78	3	42	0.53	50.70	1.90	27.76
14	Suryamannar	6.5	0.01	0.18	68	2	80	0.65	38.30	1.30	18.96
15	Bahour	7.2	0.02	0.31	80	2	138	1.35	11.10	2.00	23.12
16	Mine I OB	5.9	0.05	0.22	75	17	78	1.27	4.20	0.40	0.68
17	Mine I OB	7.3	0.03	0.20	69	3	41	0.36	3.90	0.50	2.76

Annexure 3.7. Details of land acquired by NLC (village wise & type wise)

No	Village	Total extent reqd	Patta lands	Poramboke lands	Total patta & Poramboke acqd upto 31 10 94
	I Mine Expansion scheme				
1	Therkumelur State I	620.27	620 27	Nil	620.27
2	Therkumelur State II	513 31	427 75	85 56	464 93
3	Vanatharayapuram	467.25	339 78	127 47	452 12
4	Vadakkumelur	12 53	11 08	1 45	12 53
5	Penyakunchi	930 88	631 82	299 06	905.27
	Total (A)	2544 24	2030 70	513 54	2455 12
	I Mine (Urgency Clause) Railway Line Diversion				
	Parvathipuram				
1	Seplanatham	9 24	5 56	3 68	8 93
2	Penyakunchi	8 07	2 61	5 46	8 07
3	Gangaikondan	18 10	11 21	6 89	17 50
4	Vadakkuvellore	4 54	4 38	0 16	4 54
5	Total (B)	10 65	8 93	1 72	10 65
		50 60	32 69	17 91	49 69
	I Mine (Urgency Clause) Exp Scheme (Block B)				
	Penyakunchi	1035 09	720 54	314 55	145 55
1	Seplanatham	118.35	79 73	38 62	66 45
2	Parvathipuram	310 34	235 43	74 91	63 18
3	Vanatharayapuram	128 28	85 05	43 23	Nil
4	Thenkuthu	283 56	48 39	235 17	Nil
5	Total (C)	1875 62	1169 14	706 48	275 18
	Total (A to C)	4470 46	3232 53	1237 93	2779 99
	II Mine Cut - Phase I				
1	Neyveli	129 99	103 05	26 94	129 99
2	Veppankunchi	389 60	255 32	134 28	389 60
3	Vadakkuvellore	1302 80	763 39	539 41	1032 80
4	Aziz Nagar	528 39	23 18	505 21	529 39
5	U Mangalam	1223 49	969 05	254 44	1223 49
6	Uthangal	75 10	74 92	0 18	75 10
	Total (D)	3649 37	2188 91	1460 46	3649 37
	II Mine Cut - Phase II				
1	U Mangalam	260 98	154 88	106 10	248 23
2	Uthangal	279 66	245 55	34 11	34 11
3	Aziz Nagar	882 61	402 00	480 61	289 78
	Total (E)	1423 25	802 43	620 82	1086 61
	II Mine Cut Exp - Phase I				
1	Veppankunchi	117 42	69 42	48 00	117 42
2	Uthangal	1011 57	862 45	149 12	914 77
3	Neyveli	205 23	178 51	27 72	201 46
4	Melpapanapattu	76 78	46 84	29 83	75 69
	Total (F)	1411 00	1157 32	253 68	1309 34

No.	Village	Total extent reqd	Patta lands	Poramboke lands	Total patta & Poramboke acqd
	II Mine Cut Exp - Phase II				
1	Neyveli	391 49	341.31	50 18	304.11
2	Keelpathy	191 54	122.97	68.57	Nil
3	Mummudicholagan	351 19	282.45	68 74	Nil
4	Veppankurichi	233 88	164.98	68 90	143.25
5	Melpapanapattu	577 76	474.95	102 81	192.81
6	Melpathy	292 79	192 47	100.32	55.03
7	Managathy	298 18	221 61	76 57	Nil
8	Kathazai	215 47	74 87	140 60	Nil
9	Uyyakondaravi	243.33	216.36	26 97	Nil
	Total (G)	2795 63	2091 97	703 66	695.20
	Total (D to G)	9279 25	6240 63	3038 62	6740 52
	630 MW Thermal Power House				
1	Ammeri	766 90	578.95	187 95	748 68
2	Kunankurichi	684.31	600 42	83 89	668 03
3	U Mangalam	6 74	5.37	1.37	6 07
4	Mudanai	306 31	266.25	40 06	306.31
5	Uthangal	360 26	333 44	26 82	345 18
	Total (H)	2124 52	1784 43	340 09	2074.27
	Total (A to H)	15874 23	11257.59	4616 64	11594 78

Annexure 3.8. Date wise noise monitoring data

Neyveli area

Station No	Station Name	Cycle	Noise level, dB(A)		Date
			Day	Night	
N 1	CHURCH (BLOCK 24)	1	51	40	7/10/94
		2	55	46	30/10/94
		3	53	44	13/11/94
N 2	HOSPITAL (BLOCK 6)	1	58	40	9/10/94
		2	53	41	30/10/94
		3	58	46	21/11/94
N 3	DISPENSARY (BLOCK 29)	1	50	43	6/10/94
		2	52	47	29/10/94
		3	55	46	13/11/94
N 4	DISPENSARY (BLOCK 8)	1	56	44	7/10/94
		2	55	45	30/10/94
		3	52	40	21/11/94
N 5	MATERIAL MANAGEMENT COMPLEX	1	57	49	6/10/94
		2	59	52	29/10/94
		3	58	52	13/11/94
N-6	NADUKKUPPAM	1	47	42	8/10/94
		2	53	43	7/11/94
		3	53	44	15/11/94
N 7	SATTAMANGALAM	1	55	43	8/10/94
		2	48	45	7/11/94
		3	51	46	15/11/94
N 8	VADALUR	1	50	44	11/10/94
		2	49	44	7/11/94
		3	50	42	15/11/94
N 9	ERUMBUR	1	53	43	11/10/94
		2	53	44	6/11/94
		3	53	41	22/11/94
N 10	SOUTH OF VELLAR	1	53	42	16/10/94
		2	51	42	6/11/94
		3	52	40	22/11/94

Neyveli area contd..

Station No.	Station Name	Cycle	Noise level, dB(A)		Date
			Day	Night	
N 11	ASH POND LAKE (THERMAL N 1)	1	54	44	9/10/94
		2	52	44	30/10/94
		3	47	46	21/11/94
N 12	THERMAL STATION 2 (EAST)	1	59	56	10/10/94
		2	59	58	31/10/94
		3	61	60	18/11/94
N 13	THERMAL STATION 2 (WEST)	1	59	56	10/10/94
		2	58	52	31/10/94
		3	59	54	18/11/94
N 14	THERMAL STATION 2 (NORTH)	1	57	56	10/10/94
		2	57	54	31/10/94
		3	55	53	18/11/94
N 15	THERMAL STATION 2 (SOUTH)	1	52	53	10/10/94
		2	56	54	31/10/94
		3	57	53	18/11/94
N 16	MINE II (EAST)	1	63	58	13/10/94
		2	61	57	14/11/94
		3	59	57	19/11/94
N 17	MINE II (WEST)	1	60	57	13/10/94
		2	65	65	14/11/94
		3	63	63	19/11/94
N 18	MINE II (NORTH)	1	61	57	13/10/94
		2	55	56	14/11/94
		3	55	56	19/11/94
N 19	MINE II (SOUTH)	1	69	69	13/10/94
		2	67	65	14/11/94
		3	67	65	19/11/94
N 20	THERMAL STATION 1 (ENTRANCE)	1	60	57	6/10/94
		2	61	58	29/10/94
		3	63	59	13/11/94

Neyveli area contd..

Source No.	Source name	Cycle	Noise level, dB(A)		Date
			Day	Night	
N21	TURBINE HALL (TS-2)	1	89	89	1/11/94
		2	90	89	12/11/94
		3	89	89	23/11/94
N22	BUCKET WHEEL EXCAVATOR OPERATOR'S CABIN	1	80	81	13/10/94
		2	82	80	14/11/94
		3	78	79	20/11/94
N23	DRILL MACHINE OPERATOR'S CABIN	1	82	80	12/10/94
		2	80	84	14/11/94
		3	83	82	20/11/94
N24	DOZER OPERATOR'S CABIN	1	87	85	12/10/94
		2	88	87	14/11/94
		3	87	88	20/11/94

Jayamkondam area

Station No	Station name	Cycle	Noise level, dB(A)		Date
			Day	Night	
N25	JAYAMKONDAM	1	58	47	18/10/94
		2	58	49	9/11/94
		3	59	50	17/11/94
N26	GANGAIKONDA CHOLAPURAM	1	56	46	18/10/94
		2	57	45	9/11/94
		3	55	45	17/11/94
N27	IRUMPULLIKURICHI	1	49	44	18/10/94
		2	54	40	9/11/94
		3	50	42	17/11/94

Bahour area

Station NO.	Station name	Cycle	Noise level, dB(A)		Date
			Day	Night	
N28	BAHOUR TOWN	1	52	45	15/10/94
		2	53	47	8/11/94
		3	55	44	16/11/94
N29	PILLAIYARKUPPAN	1	52	45	15/10/94
		2	51	44	8/11/94
		3	53	45	16/11/94
N30	THIRUPPANAMPAKKAM	1	52	44	15/10/94
		2	53	43	8/11/94
		3	54	44	16/11/94

Annexure 3.9. List of blocks in the study area

Neyveli & Jayamkondam

1. Alathur
2. Andimadam
3. Annagramam
4. Ariyalur
5. Bhuvanagiri
6. Chinnasalem
7. Cuddalore
8. Gingee
9. Jayamkondam
10. Kallakkurichi
11. Kammapuram
12. Kanai
13. Karur
14. Kattumannarkoil
15. Kandamangalam
16. Keerapalayam
17. Koliyanur
18. Komaratchi
19. Kurinjipadi
20. L Palur
21. Lalgudi
22. Mailam
23. Manikandam
24. Mangalur
25. Manapparai
26. Marakkanam
27. Melmalayanur
28. Mugaiyur
29. Nallur
30. Olakkur
31. Panruti
32. Parangipattai
33. Palur
34. Rishivandiam
35. Sankarapuram
36. Sendurai
37. Tattayyangarpettai
38. Thiagadugam
39. Thirumanur
40. Thiruverambur
41. Thiruvennainellur
42. Tirukkoyilur
43. Tirunavalur
44. Turaiyur
45. Ulundurpet
46. Vallam
47 Vanur
48. Vikravandi
49. Vridhachalam

Bahour

1. Pondicherry
2. Ariankuppam
3. Ozhukari
4. Mannadipet
5. Villianur
6. Bahour
7. Nettapakkam

Annexure 3.10. List of industries in the study region

Neyveli area

1. Thermal station I, NLC Ltd
2. Thermal station II, NLC Ltd
3. B&C Plant, NLC Ltd
4. Fertiliser plant, NLC Ltd
5. MRK Co-op sugar mills, Sethiatope, Chidambaram
6. Chemplast, Distillery Division, Kadampuliyur, Panruti
7. Hindustan Lever, Tannery Division, Marungur, Panruti
8. Nycer India Limited, Vadalur

Cuddalore area

1. Usta-te-biotech industries, SIPCOT, Cuddalore
2. Pentasia Chemicals, SIPCOT, Cuddalore
3. Vanavil Dyes and Chemicals, Kudikadu, Cuddalore
4. TANFAC industries, SIPCOT, Cuddalore
5. Urethane India Ltd, Semmankuppam, Cuddalore
6. Peroxide India Ltd, Semmankuppam, Cuddalore
7. Morgan Industries Ltd, SIPCOT, Cuddalore
8. SPIC Pharma Chemicals Ltd, SIPCOT, Cuddalore
9. JK Pharma Chemicals Ltd, SIPCOT, Cuddalore
10. EID-Parry India Ltd, Nellikuppam, Cuddalore
11. Parry Confectioneries Ltd, Nellikuppam. Cuddalore
12. INTEC Chemicals Ltd, SIPCOT, Cuddalore
13. Nova Roofings Ltd, SIPCOT, Cuddalore
14. Indo-Doha Chemicals, SIPCOT, Cuddalore
15. GJB Chemicals Ltd, SIPCOT, Cuddalore
16. Tan-tech Agro Chemicals Ltd, SIPCOT. Cuddalore
17. Victory Chemicals Ltd, SIPCOT, Cuddalore
18. Amajin Agro Exports Pvt Ltd, SIPCOT, Cuddalore
19. Ross Chem Industries Ltd, SIPCOT, Cuddalore
20. Morgan acids and Chemicals Ltd, SIPCOT, Cuddalore
21. Indag Pvt Ltd, SIPCOT, Cuddalore
22. Oswali Chemicals Ltd, SIPCOT, Cuddalore
23. Omnicast Precision tubes Ltd, SIPCOT, Cuddalore
24. Calac Pvt Ltd, SIPCOT, Cuddalore
25. Shasun Chemicals and Drugs Ltd, SIPCOT, Cuddalore
26. Pioneer Miagi Chemicals Ltd, SIPCOT, Cuddalore
27. Tagros Chemicals Ltd, SIPCOT, Cuddalore
28. Kumar Chemicals Ltd, SIPCOT, Cuddalore
29. Maruthi Laboratories, SIPCOT, Cuddalore
30. Vijay Phosphates, SIPCOT, Cuddalore
31. Loyal Super Fabrics Ltd, SIPCOT, Cuddalore

Pondicherry area

1. Anglor French Textiles, Cuddalore Road, Mudaliarpet, Pondicherry
2. East Coast Steels Ltd, Vazhudavur Road, Kurumbapet, Pondicherry
3. New Horizon Sugar Mills Ltd, Ariyur, Pondicherry
4. The Pondicherry Papers Ltd, Cuddlaore Road, Pillayarkuppam, Pondicherry
5. Pondicherry Coop Spinning Mills Ltd, Thirukuvanai, Pondicherry
6. Pondicherry Coop Sugar Mills Ltd, Lingareddipalayam, Pondicherry
7. Protchem Industries (India) Ltd, T N Palayam, Pondicherry
8. Sri Sarathi Mills, Mudaliarpet, Pondicherry
9. Swadeshi Cotton Mills Ltd, Maraimalai Adigal Salai, Pondicherry
10. Ballarpur Industries Ltd, Thondamanatham Village, Pondicherry
11. Amaravathi Chemicals Ltd, Abishekapakkam Post, Pondicherry
12. Chemfab Chlorartes, Thavalakuppam, Pondicherry
13. Coromandal Granite Co Pvt Ltd, Sedarpet, Pondicherry
14. Golden Paper and Board Mills Pvt Ltd, Sedarpet, Pondicherry
15. Greaves Foseco Ltd, Industrial Estate, Mettupalayam, Pondicherry
16. Hindustan Lever Ltd, PIPDIC Industrial Estate, Mettupalayam, Pondicherry
17. JBF Industries Ltd, Panithittu Road, Kirumampakkam, Pondicherry
18. Lotus Roofings Pvt Ltd, Sedarpet, Pondicherry
19. Mailam Mettalogam Pvt Ltd, Sedarpet, Pondicherry
20. Mittal Ispat Pvt Ltd, Kirumampakkam, Pondicherry
21. Ponds India Ltd, Mettupalayam, Pondicherry
22. Pondicherry Extraction Pvt Ltd, Mettupalayam, Pondicherry
23. Pondicherry Distilleries Ltd, Goubert Avenue, Pondicherry
24. Sharada Castings Pvt Ltd, Kirumampakkam, Pondicherry
25. Supreme Industries Ltd, Sedarpet Industrial area, Pondicherry

Annexure 4.1 Industrial Water Balance (1993-94)

Thermal Station 1

NUMBER OF UNITS:	50 MW X 6 + 100 MW X 3			
UNIT	INPUT		OUTPUT	
	SOURCE (from)	QUANTUM (cu.m./hr)	SINK (to)	QUANTUM (cu m./hr)
COOLING TOWER	Mine I	2193	HAD	1133
			EVAP LOSS	1060
PROCESS PLANT	BOREWELL	90	HAD	10
			FOR STEAM GEN.	80
BALANCE		2283		2283

Comments: Effluent from TS-1 doesn't join any surface body directly. It goes for hydro ash disposal (HAD) system, and the supernatant from the ash pond goes on the land.

a) Sanitary uses are met by bore well water 155 cu.m./hr
(This goes as sewage)

COOLING TOWER DETAILS						
UNITS (Nos)	ASH REQUIRED (cu m./hr)	SOURCES OF WATER TO ADPH (cu m./hr)			EVAPORATION LOSSES (cu.m./hr)	TOTAL CT MAKE UP REQUIRED (cu m./hr)
		BLOW DOWN QTY	STORM WATER RECOVERY	ASH WATER RECOVERY		
9 UNITS (6x50MW + 3x100MW)	1133	1133	0	0	1060	2193

Note:

1. Make up water (FROM Mine-1)
2. Slag water demand (HAD) (Hydraulic Ash disposal)

Thermal station 2

NUMBER OF UNITS·	210 MW X 7 UNITS 3 UNITS COME UNDER STAGE 1 4 UNITS COME UNDER STAGE 2			
UNIT	INPUT		OUTPUT	
	SOURCE	QUANTUM (cu m./hr)	SINK	QUANTUM (cu m./hr)
COOLING TOWER	MINE II	7373	HAD	3813
	(RECYCLED 2000 cu m./hr.)		EVAP LOSS	3560
PROCESS PLANT	BOREWELL	140	HAD	35
			FOR STEAM GEN	105
BALANCE		7513		7513

Comments: Effluent from TS-2 consisting of process effluent and ash pond overflow, travels to peria eri/jumbo eri via western garland canal. During monsoons the overflow from peria eri joins the parvanar.

Sanitary requirement of water = 95 cu.m./hr (Borewell water)

a) Cooling tower and ash pond details
As in TS-1 ash slurry requirements are met by blowdowns However.in case of TS-2

i) water is recycled from ash pond of stage 2 bund = 1000 cu m./hr (Max)
ii) storm water of mines is also utilised = 1000 cu.m./hr (Max)

UNITS (Nos)	ASH REQUIRED	SOURCES OF WATER TO ADPH (cu m./hr)			EVAPORATION LOSSES (cu m)	TOTAL CT MAKE UP REQUIRED (cu m./hr)
		BLOW DOWN QTY	STORM WATER RECOVERY	ASH WATER RECOVERY		
	1	2	3	4	5	6
3 UNITS-ST1	3300	2400	900	___	1440	3840
4 UNITS-ST2	3280	1413	1000	867	2120	3533
ALL UNITS	6580	3813	1000	1000	3560	8140
(ST1+ST2)						

Note:

1. Ash req. Of water = 2+3+4
2. CT water make up = 2+5

b) Process water

UNITS (NOS)	TOTAL MW POWER GENERATED (MW)	BOILER NOS	STEAMING CAPACITY (TOTAL) (cu m./hr)	TOTAL BOILER MAKE-UP WATER (DM PLANT) (cu m./hr)	REGENERATION OF DM PLANT (cu m./hr)
			1	2	3
210MW X 7	1470	7	4592	140	35

Note:

Make up water (2) = 8% of total steam generated

Fertilizer industry

UNIT	INPUT		OUTPUT	
	SOURCE	QUANTUM (cu.m./hr)	SINK	QUANTUM (cu m./hr)
UREA PLANT (BAROM COND)	LAKE-MINE I	630	M EFFLUENT	500
			ASH POND	130
COOLING TOWER (MAKE UP)	LAKE-MINE I	260	M EFFLUENT	60 (BLOWDOWN)
			EVAP LOSS	200
PROCESS STEAM	PSP	95	PSP (RECYCLED)	67
			USEFUL STEAM	18
DM WATER FOR G S (AMMO PLT)	PSP	30	EFFLUENT (CYNIDE TREAT)	6
			RECYCLE	24
BF WATER FOR G S	PSP	70	ASH POND	70
BOILER BLOW-DOWN WATER	PSP	2	ASH POND	2
SPENT LYE & GAS CONDENSATE-FLOOR WASHINGS PUMP GLAND COOLING		20	M EFFLUENT	20
BALANCE		1107		1107

PSP	=	Process steam plant
U.P	=	Urea plant
M.Effluent	=	Main effluent stream
Evap.Loss	=	Drift and evaporation losses from the cooling tower
MWCT	=	Make up water for cooling tower (make up water for cooling tower is sum of blowdown & evap.loss
G.S	=	Gassification section of Ammonia plant
DM Water	=	de-mineralised water
BF Water	=	Boiler feed water

Comments: The effluent stream comprises of mainly the barometric-condensate from the urea plant and supernatant flow from the ash pond. This effluent along with B&C effluent enters into Walaja tank. Hence,

Main effluent stream from the plant: 806 CUM./HR

D) B&C Plant

UNIT	INPUT (FROM)		OUTPUT (TO)	
	SOURCE	QUANTUM (cu.m./hr)	SINK	QUANTUM (cu m./hr)
F Q C	LAKE-MINE1	175	EFFLUENT	175
C.H	LAKE-MINE1	100	EFFLUENT	100
B U	LAKE-MINE1	42	EFFLUENT	42
C & TP				
MWCT-1	LAKE-MINE1	300	EFFLUENT	75 (BLOWDOWN)
			EVAP LOSS	225
MWCT-2	LAKE-MINE1	50	EFFLUENT	12.5 (BLOWDOWN)
			EVAP LOSS	37.5
PROCESS STEAM	PSP	180	RECYCLE (TO PSP) (CONDENSATE)	108
			USEFUL STEAM (WORK)	72
BALANCE		847		847

Comments: This effluent along with fert. effluent enters into Walaja tank.

Note:

F.Q.C	:	Fire quenching and control operation (for briquettes)
C.H	:	Char handling unit
B.U	:	Briquetting unit
C & TP	:	Carbiniser and tar products
MWCT-1	:	Make up water for cooling tower 1
MWCT-2	:	Make up water for cooling tower 2
PSP	:	Process steam plant

Total water consumption: 667 cu.m/hr (Excluding process steam consumption)
Total effluent flow: 404.5 cu m/hr

E) Process steam plant

UNIT	INPUT (FROM)		OUTPUT (TO)	
	SOURCE	QUANTUM (cum/hr)	SINK	QUANTUM (cum/hr)
D M PLANT	BOREWELL	220	FERT AS COLD DM H2O	30
AUXILARY STEAM (RECYCLED)		69	FERT AS BF WATER	70
			STEAM TO FERT ,B&C	344
CONDENSATE RETURN (FROM FERT)		67	STEAM TO AIR PREHEATER	4
CONDENSATE RETURN (FROM B&C)		 108	BOILER BLOWDOWNS TAR HEATING SOOT BLOWING ATOMISING STEAM	10 6
BALANCE		464		464

D.M PLANT : Dimineralisation plant
BF WATER : Boiler feed water

Hence, total raw water demand from borewell : 220 cu.m./hr

Annexure 6.1. Mine-wise, Year-wise land requirements (till 2020)

Mine	Year	Total	Land requirement (Ha)				
			Agri.	Forest	Waste land	Water body	Other
Mine 1	Till 1994	1410.8					
	1995-2020	2108.6	1810.9	0.0	152.3	0.0	145.4
	Total	3519.4					
Block A	2018-2020	100.2	100.2	0.0	0.0	0.0	0.0
Mine 2	Till 1994	1117.4					
	1995-2020	2414.9	1982.3	0.0	251.4	0.0	181.2
	Total	3532.3					
Block B	2009-2020	958.0	873.1	0.0	84.9	0.0	0.0
Neyveli sub-area	Till 1994	2528.2					
	1995-2020	5581.7	4766.5	0.0	488.6	0.0	326.6
Jayamkondam sub-area	1998-2020	2308.1	2281.4	0.0	26.7	0.0	0.0

Land requirement (yearwise)- upto 2020

Neyveli sub-area

Year	Land requirement (Ha)				Total
	Mine 1	Mine 2	Block A	Block B	
1995	44.4	90.7			135.1
1996	116.6	101.3		98.8	217.9
1997	141.7	98.8		43.7	240.5
1998	80.6	118.2		43.7	198.8
1999	87.1	113.2		78.4	200.3
2000	88.0	98.2		70.6	186.2
2001	66.0	111.4		94.3	177.4
2002	83.4	108.2		96.2	191.6
2003	71.7	110.2		93.9	181.9
2004	76.5	95.4		96.2	171.9
2005	70.9	87.5		101.6	158.4
2006	68.8	100.6		68.1	169.4
2007	73.5	85.6		72.5	159.1
2008	79.7	78.1			157.8
2009	84.3	69.4			252.5
2010	86.6	63.8			194.1
2011	98.6	66.9			209.2
2012	82.8	69.4			230.6
2013	99.3	77.5			247.4
2014	103.7	80.6			278.6
2015	109.5	83.1			288.8
2016	91.2	93.1			278.2
2017	66.3	90.0			252.5
2018	59.0	100.0	33.4		294
2019	40.4	111.2	33.4		253.1
2020	38.0	112.5	33 4		256.4

Land requirement (yearwise)- upto 2020

Jayamkondam sub-area

Year	Land requirement (Ha) Jayamkondam (Total)
1995	
1996	
1997	
1998	98.0
1999	38.0
2000	11.7
2001	127.0
2002	138.8
2003	156.4
2004	156.0
2005	161.3
2006	161.6
2007	145.4
2008	143.2
2009	139.7
2010	150.0
2011	81.9
2012	71.8
2013	65.9
2014	66.5
2015	65.2
2016	67.5
2017	66.4
2018	66.7
2019	62.4
2020	66.7

Annexure 6.2. Land occupation due to mining beyond 2020

Mine	Year	Total	Land requirement (Ha)				
			Agriculture	Forest	Waste land	Water body	Other
Mine 1	2021-2022	53 6	35 3	0.0	0 0	0 0	18 3
Mine 2	2021-2031	1416 3	1260 2	0 0	156 1	0 0	0 0
Block A	2021-2039	1055 5	876 8	0.0	178 7	0 0	0 0
Block B	2021-2051	2117	1508 7	0 0	608 3	0.0	0 0
Mine 3	2029-2073	3572 1	3061 8	0 0	176 2	264 3	69 8
South Vellar	2036-2083	4695 0	4457 4	0.0	237 6	0 0	0 0
Neyveli sub-area	2021-2083	12909 5	11200 2	0 0	1356 9	264 3	88 1
Jayamkondam sub-area	2021-2069	4044 6	3912 5	0 0	132 1	0 0	0 0
Bahour sub-area	2048-2100	4675	4096 5	0 0	578 5	0 0	0 0